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The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Humphrey Pumps for Australia (With a Two-Page Drawing).

Experimental Researches in Propeller Cavitation—No. IV.

A Remarkable Motor Car.

Internal Combustion Engine Phenomena.

Links in the History of the Locomotive—Marc Seguin—No. II.

Engineers of the Future.

Brassey's Annual.

Institution of Electrical Engineers.

PUBLIC NOTICES

INDIAN SERVICE OF ENGINEERS.

The Secretary of State for India in Council will, in 1924, APPOINT 15 ASSISTANT EXECUTIVE ENGINEERS for this Service, if so many suitable candidates present themselves.

Every candidate must be a British subject or a ruler or subject of any State in India in respect of whom the Governor-General of India in Council has made a declaration that he is to be considered eligible.

Candidates must be not less than 21 years of age and not more than 24 years on 1st August, 1924.

They must either (1) have obtained one of certain recognised University degrees or other distinctions in Engineering, or (2) have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers or been exempted by the Institution from such examination, or (3) produce the required evidence that they are otherwise eligible under the Regulations. They must in addition have had at least one full year's practical experience of Civil Engineering under a qualified Civil Engineer at the time when they appear before the Selection Committee.

Applications from candidates must reach the India Office not later than 1st April. Printed forms, together with information regarding the conditions of appointment, may now be obtained from the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W. 1.

India Office, London,
14th December, 1923. 4372

District Engineer Required by the GOVERNMENT of PALESTINE for the RAILWAY DEPARTMENT for three years' service, with prospect of permanency. Salary £E540, rising by annual increments of £E25 to £E750 a year. Expatriation allowance of £E50 a year, plus a variable cost of living allowance at present 5 per cent., based on fixed minimum pay of appointment plus an additional amount of £E27 a year. Free first-class passages. Candidates, aged 30 to 35, preferably single, must have had at least 10 years' experience on home railways on maintenance and construction work. Should be an A.M.I.C.E.—Apply at once in writing, stating age, whether married or single, and giving brief details of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting at the top of application M/12,484. 4412

University of Birmingham.

FACULTY OF SCIENCE.

PROFESSORSHIP OF CIVIL ENGINEERING.

The Council of the University invites APPLICATIONS for the CHAIR of CIVIL ENGINEERING.

The stipend will be £1000 a year.

The Professor will be allowed to take higher consultative work, to keep in touch with civil engineering practice, provided that it does not interfere with his University duties.

Applications, accompanied by fifty copies of testimonials, should be received by the Secretary not later than February 4th, 1924.

The successful candidate will be expected to begin his duties on October 1st, 1924.

Further particulars may be obtained from
GEO. H. MORLEY,
4329 Secretary.

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for:
5000 100-TON SCREW COUPLINGS.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 18th December, 1923.

A fee of £1 will be charged for the specification, which is not returnable.

Tenders must be submitted not later than Noon on Monday, 7th January, 1924.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
R. C. VOLKERS,
4366 Secretary.

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for:
134 STEEL ENGINE TYRES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 19th December, 1923.

A fee of 10s. will be charged for the specification, which is not returnable.

Tenders must be submitted not later than Noon on Thursday, 3rd January, 1924.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
R. C. VOLKERS,
4381 Secretary.

Bengal-Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for:
3500 BUFFER PLUNGERS AND 4000 BUFFER CASES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 17th December, 1923.

A fee of £1 will be charged for the specification, which is not returnable.

Tenders must be submitted not later than Noon on Friday, 4th January, 1924.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
R. C. VOLKERS,
4383 Secretary.

City of Liverpool.

NEW STEAM HOPPER BARGE.

The Corporation of Liverpool REQUIRE a NEW STEAM HOPPER BARGE suitable for house refuse of approximately 1000 tons capacity, and are prepared to receive TENDERS from shipbuilders and engineers.

Copies of specification, general conditions, and form of Tender will be forwarded upon receipt of application in writing to the City Engineer, Municipal Buildings, Dale-street, Liverpool.

Sealed Tenders, addressed to "The Town Clerk, Municipal Buildings, Liverpool," and endorsed "Tender for New Steam Hopper Barge," must be forwarded through the post so as to be received not later than Twelve o'clock Noon on Tuesday, the 22nd January, 1924.

WALTER MOON,
Town Clerk.
11th December, 1923. 4340

PUBLIC NOTICES

City of Nottingham.

TRENT BRIDGE WIDENING.

Contractors desirous of submitting TENDERS for the above WORK are requested to send in their names immediately to Mr. T. Wallis Gordon, City Engineer and Surveyor, Guildhall, Nottingham.

The work will probably be divided into contracts comprising:—

(a) STEEL WORK.
(b) CONSTRUCTION of PIERS and ABUTMENTS.

Applications will only be considered from firms having had recent experience in bridge construction.

W. J. BOARD,
Town Clerk.
Guildhall, Nottingham,
17th December, 1923. 4368

Macclesfield Corporation Waterworks.

TRENTABANK SCHEME.

CONTRACT NO. 2.—PIPE LAYING.

The Water Committee invite TENDERS from competent persons for the LAYING and JOINTING of about 3 1-3rd MILES of 18in., about 1-3rd MILE of 14in., 12in., 6in., and 3in. CAST IRON PIPES, together with the FIXING of the necessary VALVES, &c., and the CONSTRUCTION of STREAM CROSSINGS, VENTURI METER-HOUSE, BREAK-PRESSURE TANK, &c., between Langley and Leadbeaters, Macclesfield.

The conditions of contract, specification, schedules, and forms of Tender, prepared by the Engineer, Herbert Lapworth, D.Sc., M. Inst. C.E., 15, Victoria-street, Westminster, S.W. 1, may be obtained on application to me on and after the 24th inst., accompanied by a cheque for Five Guineas, which will be refunded on receipt of bona fide Tenders and the return of all documents.

Copies of the plans and drawings will be available for inspection at my office on or after the 20th inst. For the convenience of contractors, Dr. Lapworth will attend at the Town Hall on Tuesday, the 1st day of January, 1924, between the hours of 10 a.m. and 3 p.m.

Sealed Tenders, endorsed "Tender for Pipe Laying," must be delivered to me at my office not later than Saturday, the 12th day of January, 1924.

The Committee do not bind themselves to accept the lowest or any Tender.

F. R. OLDFIELD,
Town Clerk.
41, Churchside, Macclesfield,
17th December, 1923. 4347

State Electricity Commission OF VICTORIA.

MELBOURNE, VICTORIA, AUSTRALIA.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form and specification will be available upon application to—

Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION NO. 24/4.—4 ONLY
100 K.V.A., 25,400-6600 V. TRANSFORMERS AND SPARES.

CHARGE.—10s. for the first two copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A third copy and any further copies will be supplied for the sum of 5s. each. This charge is not returnable.

PRELIMINARY DEPOSIT.—A preliminary deposit of £10 is to be lodged with Tender.

The specification may be inspected at the above-mentioned office.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m., 11th February, 1924.

E. LIDDELOW,
4294 Secretary.

PUBLIC NOTICES

Mid Sussex Joint Water Board.

HOLY WELL PUMPING STATION, HOKSTED KEYNES, SUSSEX.

CONTRACT NO. 1.

The Mid Sussex Joint Water Board invite TENDERS for the SUPPLY and ERECTION of DUPLICATE PUMPING PLANT, comprising Vertical Diesel Solid Injection Oil Engine of approximately 140 B.H.P., together with Centrifugal Pumps, each of 32,000 gallons per hour capacity, with Suction and Delivery Piping, Valves, &c.

Copies of the specification, &c., may be obtained from the undersigned upon payment of a deposit of £3 3s., which will be returned upon receipt of a bona fide Tender and the return of any documents supplied.

Tenders, in sealed envelopes, endorsed "Tender for Pumping Plant," are to be addressed to the Clerk to the Mid Sussex Joint Water Board, Boltro-road, Haywards Heath, and delivered there not later than 10 a.m. on Friday, the 18th day of January, 1924.

The Board do not bind themselves to accept the lowest or any Tender.

FRANCIS MARTIN, M.I. Mech. E.,
Engineer.
Waterworks Offices,
Boltro-road, Haywards Heath,
18th December, 1923. 4392

Mid Sussex Joint Water Board.

HOLY WELL PUMPING STATION, HOKSTED KEYNES, SUSSEX.

CONTRACT NO. 2.

The Mid Sussex Joint Water Board invite TENDERS for the SUPPLY and ERECTION of FIVE MECHANICAL FILTERS, any four to be capable of dealing with 768,000 gallons of water per 24 hours, to be erected at the Holy well Pumping Station.

Copies of the specification, &c., may be obtained from the undersigned upon payment of a deposit of £3 3s., which will be returned upon receipt of a bona fide Tender and the return of any documents supplied.

Tenders, in sealed envelopes, endorsed "Tender for Mechanical Filters, &c.," are to be addressed to the Clerk to the Mid Sussex Joint Water Board, Boltro-road, Haywards Heath, and delivered there not later than 10 a.m. on Friday, the 18th day of January, 1924.

The Board do not bind themselves to accept the lowest or any Tender.

FRANCIS MARTIN, M.I. Mech. E.,
Engineer.
Waterworks Offices,
Boltro-road, Haywards Heath,
18th December, 1923. 4393

Mid Sussex Joint Water Board.

CONTRACT NO. 3.

The Mid Sussex Joint Water Board invite TENDERS for the SUPPLY and DELIVERY of about 1350 TONS of CAST IRON SOCKET PIPES and SPECIALS of 18in., 12in., 9in., 6in., 4in., and 3in. diameters, manufactured in accordance with the British Standard Specification.

Copies of the specification, &c., may be obtained from the undersigned upon payment of a deposit of £2 2s., which will be returned upon receipt of a bona fide Tender and the return of any documents supplied.

Tenders, in sealed envelopes, endorsed "Tender for Pipes," are to be addressed to the Clerk to the Mid Sussex Joint Water Board, Boltro-road, Haywards Heath, and delivered there not later than 10 a.m. on Friday, the 18th day of January, 1924.

The Board do not bind themselves to accept the lowest or any Tender.

FRANCIS MARTIN, M.I. Mech. E.,
Engineer.
Waterworks Offices,
Boltro-road, Haywards Heath,
18th December, 1923. 4394

PUBLIC NOTICES

Great Northern Railway (Ireland).

The Directors are prepared to receive TENDERS for SUPPLY of:—
BULL-HEAD RAILS,
FLAT-BOTTOM RAILS, and
FISH-PLATES
(of British Standard Sections); also
CAST IRON CHAIRS, and
PERMANENT WAY FASTENINGS.

Specifications and drawings can be obtained from the undersigned.

Tenders, made out on forms supplied by the Company, should be delivered, under sealed cover, endorsed "Tender for Rails, &c.," not later than 10 a.m. on Friday, 18th January, 1924.

The Directors do not bind themselves to accept the lowest or any Tender.

J. B. STEPHENS,
Secretary.
Amiens-street Station, Dublin,
18th December, 1923. 4393

Manchester Corporation.

The Rivers Committee invite TENDERS for the CONSTRUCTION of MAIN DRAINAGE WORK No. 5 (New Sewer, Great Ancoats-street, Swan-street, and Rochdale-road; from Adair-street to Market street, Blackley).

Plans may be seen and specifications, bills of quantities, and forms of Tender obtained on application at the City Engineer's Office, Town Hall, Manchester, on payment to the City Treasurer of £10 10s., which sum will, after the Corporation have come to a decision upon the Tenders received, but not before, be returned to the person submitting a bona fide Tender.

All cheques or postal orders are to be made payable to the order of "The Corporation of Manchester."

Tenders, enclosed in the official envelope and addressed to the Chairman of the Rivers Committee, are to be delivered at the City Engineer's Office not later than 9.30 a.m. on Saturday, the 19th January, 1924.

The Corporation do not bind themselves to accept the lowest or any Tender.

P. M. HEATH,
Town Clerk.
Town Hall, Manchester,
18th December, 1923. 4327

SITUATIONS OPEN

WANTED, POWER STATION SUPERINTENDENT for North Midlands, age under 40. Thorough experience Stirling Boilers and Turbo-generators. No testimonials with application. Salary £300.—Address, 4381, The Engineer Office. 4381 A

WANTED, WORKS CHARGE ENGINEER IMMEDIATELY for a Cotton Spinning and Weaving Mills in Oporto, Portugal. Must have experience of modern high-class Steam Engines and Continuous current Electric Generating Plant. "Babcock" Boilers, Millwright Work, and also be thoroughly capable of supervising maintenance repairs to textile machinery with a staff of Portuguese mechanics.

Knowledge of the Portuguese language an advantage.

A house on the site of the works rent free.

Write, stating age, experience, and salary required, to Box 534, at Horncastle's, 60, Cheapside, London, E.C. 2. F3440 A

ENGINEER WANTED by a Large Firm of Engineers in the Midlands, to Take Control of the Engineering Side under the Managing Director. Applications only desired from those having the highest qualifications and experience in the design and manufacture of Heavy Oil and Gas Engines. State age, experience, and salary required. Applications will be treated as strictly confidential.—Address, 4330, The Engineer Office. 4330 A

EXPERIENCED MANAGER REQUIRED for Large Steel Foundry (North-East Coast) carrying out Warship, Merchant Marine, Locomotive and General Work. State when available and remuneration required.—Address, 4395, The Engineer Office. 4395 A

HEAD RATE FIXER WANTED for Marine Engine Works, North-East Coast. Previous experience in similar work and knowledge of Marine Engine Works practice essential.—Address, giving full particulars, references, and salary, 4378, The Engineer Office. 4378 A

REQUIRED, ENGINEER SALESMAN (High-class) for Japan. State qualifications and salary required.—write, Box No. 605, Advertising Offices, 84, Queen Victoria-street, London, E.C. 4. 4387 A

SITUATIONS OPEN (continued) Page 2.

SITUATIONS WANTED, Page 2.
PARTNERSHIPS, Page 2.
PATENTS, Page 2.
MACHINERY, &c., WANTED Page 2.
FOR SALE, Pages 2, 3 and 92.
AUCTIONS, Page 92.
PREMISES TO LET OR WANTED Page 92.
WORK WANTED, Page 3.
AGENCIES, Page 2.
MISCELLANEOUS, Page 2.

For Advertisement Rates see Page 671, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS, Page 91.

SITUATIONS OPEN (continued)

OLD-ESTABLISHED FIRM of CRANE MAKERS are prepared to receive APPLICATIONS for the POST of DESIGNER MANAGER. Practical experience essential, mechanical and electrical, also must have commercial experience. State age, references, and salary required.—Address, 4404, The Engineer Office. 4404 A

SALES ENGINEER REQUIRED as OUTSIDE REPRESENTATIVE (to travel the country) by firm of Mechanical and Constructional Engineers. Energy and an aptitude for securing business essential. State age, married or single, experience, and salary expected.—Address, 4385, The Engineer Office. 4395 A

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, REQUIRE the SERVICES of a FOUNDRY WORKS MANAGER.—Apply in writing, enclosing photograph, to the FOUNDRY GENERAL MANAGER. 4384 A

TRAVELLER REQUIRED for London Area, for the Sale of Extruded Brass Rod, by one of the leading manufacturers. Must have first-class knowledge of the trade; none others need apply. State experience (fully) in confidence, age, and salary required.—Address, 4407, The Engineer Office. 4407 A

WANTED, Capable DRAUGHTSMAN, Accustomed to High-pressure Hydraulic Work.—Apply by letter, stating age, experience, and wage required, to THE HYDRAULIC ENGINEERING CO., Ltd., Chester. 4382 A

DRAUGHTSMAN for Internal Combustion Work, preferably with experience in Aircraft Engine design.—Address, stating age, experience, and salary required, 4403, The Engineer Office. 4403 A

DRAUGHTSMAN, JUNIOR, WANTED, with Experience in the preparation of Engineering Drawings and Diagrams for book illustration purposes. State age, salary, and experience.—Address, 4411, The Engineer Office. 4411 A

DRAUGHTSMAN REQUIRED, to Design and Detail Steel Structures, Buildings, Roofs, Gantries, Hoppers, &c. Experienced men only to apply in writing to ARTHUR DUCKHAM and CO. (1920), Ltd., 52, Grosvenor-gardens, London, S.W. 1, stating qualifications, age, and salary expected. 4400 A

DRAUGHTSMAN (TEMPORARY) REQUIRED, for Motor Firm in the Midlands. Must be experienced in Light Car designs. The position carries prospects and may prove a permanency.—Address, 4388, The Engineer Office. 4388 A

DRAUGHTSMEN. — SEVERAL Experienced DRAUGHTSMEN WANTED; accustomed to High-speed Heavy Oil Engine Work. Must be quick and accurate. Particulars of experience, age, and wages desired.—Address, "ACCURATE," Wm. Porteous and Co., Advertising Agents, Glasgow. P8436 A

DRAUGHTSMEN WANTED for Steam Turbine Details and Power Station Lay-outs.—Write, stating age, training, experience, and salary expected, to CHIEF DRAUGHTSMAN, English Electric Co., Ltd., Rugby. 4408 A

FIRST-CLASS STRUCTURAL DRAUGHTSMEN REQUIRED; none but experienced men need apply. State full particulars, age, salary required.—THE CLEVELAND BRIDGE and ENGINEERING CO., Ltd., Darlington. 4076 A

PUMP DESIGNER, with Experience of Multi-stage Pumps, REQUIRED. Good general and practical experience necessary. Replies must give age, details of experience, and salary required.—Address, 4386, The Engineer Office. 4386 A

REQUIRED, First-class DRAUGHTSMAN, Competent on Railway and Tramway Traction Motor Work.—Apply, THE ENGLISH ELECTRIC CO., Ltd., Dick, Kerr Works, Preston. 4320 A

SEVERAL JUNIOR STRUCTURAL DETAIL DRAUGHTSMEN WANTED AT ONCE for temporary work; must be quick and accurate.—Write, stating age, experience, and salary required, to FRASER and CHALMERS ENGINEERING WORKS, Erith, Kent. 4396 A

PRESS FOREMAN WANTED. First-class Man, accustomed to the production of Light and Heavy Pressings for All-steel Railway Carriages and Wagons.—Apply, Box 27, Leeds Advertising Agency, Standard Buildings, Leeds. 4321 A

SITUATIONS WANTED

A FULLY QUALIFIED CIVIL ENGINEER (M. Inst. M. and C.E.), with 7 years' experience in England and 18 in India, DESIRES a POST. Of undeniable integrity and holds excellent testimonials.—Address, 4273, The Engineer Office. 4273 B

ENGINEER (32), 1st B.O.T., Ex Chief Engineer, wide experience all class engine and boiler repairs, moderate salary, excellent references, REQUIRES POST as WORKING ENGINEER or MECHANIC.—Address, P8443, The Engineer Office. P8443 B

ENGINEER (45), M.I.M.E., M.I. and S.I., thoroughly practical and commercial, of proved ability, 18 years' administrative experience with railway rolling stock, motor vehicles, and power plants, DESIRES POSITION as GENERAL MANAGER, REPRESENTATIVE, or similar. London district preferred. Salary £500 to £750.—Address, P8391, The Engineer Office. P8391 B

MECHANICAL ENGINEER, Accustomed to Erection and maintenance of Sugar, Colliery and all Mining Machinery, DESIRES POST, home or abroad.—Address, P8439, The Engineer Office. P8439 B

SALES ENGINEER, Young, Experienced, at Liberty early New Year, SEEKS OPENING with reputable firm.—Address, P8415, The Engineer Office. P8415 B

SALES or PUBLICITY APPOINTMENT DESIRED by Engineer (33), accustomed to travelling and interviewing. Good general engineering experience.—Address, P8437, The Engineer Office. P8437 B

WORKS.—BUILDING ASSISTANT to Chief Engineer DESIRES POST. Capable architect and surveyor, take control of new, alteration and maintenance work, able to organise works building dept. or control outside contractors, measure up, check accounts, extras and variations, write specifications, estimate, allocate costs, survey and supervise construction.—Address, P8410, The Engineer Office P8410 B

COMMERCIAL RECONSTRUCTIONS, LTD.,
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Engineering undertakings reorganised by specialists.
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Active management where desirable.
Additional Capital in approved cases.
The fullest investigations are invited and required.

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
London, E.C. 4.
Established over 70 years.

ENGINEER (MECHANICAL) WANTED, with Electrical knowledge, on a mining property in course of development in North Wales. Must have small financial interest. Good salary and prospects.—Address, P8444, The Engineer Office. P8444 C

MESSRS. TITCHFIELD, 23, Gt. Titchfield-street, Oxford-circus, London (Museum 6665), have 12 CLIENTS with £1500-£3000 to INVEST in sound Engineering Concerns, either as active directors, partners, or employees. Balance sheets required and must stand s/cs and solicitors' investigations. First-class references given. 4397 C

OPENING for Qualified ENGINEER as WORKS DIRECTOR to South London Manufacturing Engineers. Applicants must be prepared to invest £1000.—Address, 4409, The Engineer Office. 4409 C

PARTNERSHIP.—PARTNER DESIRED, to Replace retiring partner in old-established, well-organised engineering works in Midlands. Sound engineering and commercial training essential. Qualification £6000.—Address, P8438, The Engineer Office. P8438 C

FOR HIRE

FOR HIRE, PUMPS and WELL-BORING TOOLS for Contractors' Deep Wells, &c., 2in. to 24in. dia.—R. RICHARDS and CO., Upper Ground-street, London, S.E. Telephone No., 978 Hop. 822 A

FOR SALE or HIRE, ELECTRIC MOTORS, from 60 to 300 H.P.; PORTABLE STEAM ENGINES, from 8 to 40 N.H.P.; STEAM BOILERS, CRANES, PUMPS, MACHINE TOOLS of every description; reasonable terms, immediate delivery.—J. F. WILLIAMS and SONS, 37, Queen Victoria-street, London, E.C. Tel., City 3938. Ex.

AGENCIES

ENGINEERS, Manufacturing a Vertical Steam Boiler of exceptional merit (some thousands already in use throughout the world) and other engineering specialities, DESIRE ENGINEERS with established connections to REPRESENT them in many chief towns of England and Ireland, also abroad.—Address, 4361, The Engineer Office. 4361 D

LIFT MAKERS, with Over 21,000 Lifts Throughout the world, WISH to APPOINT SUB-AGENTS in all towns, U.K. and Ireland.—Address, P8434, The Engineer Office. P8434 D

POLDI STEEL CO. (ENGLAND), LTD., Invite APPLICATIONS for the POSITION of REPRESENTATIVE in Lancashire and Yorkshire. It is essential that applicants have technical knowledge of High-grade Tool Steels and Motor Construction Steels, and must be able to demonstrate on all questions arising. An established connection in this area is desirable. Salary, expenses, and commission will be paid.—Letters, stating qualifications, to be addressed to ERNEST PENN, 156, Caledonian-road, London, N. 1. 4406 D

MACHINERY, &c., WANTED

WANTED, a MACHINE for Making TWISTED WALL TIES, complete.—Address, P8432, The Engineer Office. P8432 F

WANTED, a Small Complete Second-hand PLANT of COTTON SPINNING MACHINERY, to spin 8-16's. State full details with maker's name and, if possible, photographs and engravings of machinery, and also production per hour according to count.—Address, P8411, The Engineer Office. P8411 F

WANTED, a 12in. Six-wheel Coupled LOCOMOTIVE, in good working order.—ARLESEY BRICK CO., Arlesey, Beds. P8441 F

WANTED, ONE GAS COOLING TOWER, at least 10ft. diameter by 40ft. high; also TWO ELECTRICALLY DRIVEN FANS, 10 M.P. each, motor 220 volts D.C.—Address, 4389, The Engineer Office. 4389 F

WANTED, Second-hand Medium-sized Cochran BOILER, in good condition, working pressure 100 lb.—Address, P8442, The Engineer Office. P8442 F

ANGLE BAR JOGGLING MACHINE, New or Second-hand. Give price and full particulars.—Address, 4410, The Engineer Office. 4410 F

ONE Brown and Sharpe 13in AUTOMATIC GEAR-CUTTING MACHINE for spurs and bevels. Must be in good condition.—Address full particulars, 4401, The Engineer Office. 4401 F

PRESSES.—WANTED to PURCHASE, SEVERAL Second-hand Taylor and Challen B.3, B.32, or B.4 PRESSES.—Full particulars to G. A. HARVEY and CO. (London), Ltd., Woolwich-road, S.E. 7. 4380 F

EDUCATIONAL

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter., and B.Sc.) personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M. Inst. C.E., M.E.S.I., F.R.S.A., &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time.—S/11, Trafford Chambers, 58, South John-street, LIVERPOOL. Ex. B

ENGINEERING EXAMINATIONS.—Day, Evening, or Correspondence Courses of Preparation for all Examinations. Thousands of successes during the past eighteen years.—G. P. KNOWLES, M.E.E., B.Sc., A.M.I.C.E., &c., 29, Victoria-street, Westminster, S.W. 1. Ex.

ENGINEERING SALES MANAGERS.—Our Special Course of Training qualifies students for posts of unlimited scope in this lucrative field. We are prepared to arrange introductions between employers and our trained candidates.—Apply, The INSTITUTE of ENGINEERING SALESMANSHIP, 338, Oxford-road, Manor. P8435 E

SURVEYING and LEVELLING.—Excellent Opportunity to acquire thorough practical instruction on work.—Address, E. MOREL, Hollybank, Woking. P8309 E

TUITION BY POST.—Inst. C.E. and I. Mech. E. Enrol now for next Exams.; 100 per cent. passes last examination. Reinforced Concrete, new comprehensive course under expert engineer, 43 8s. Write for particulars.—PENNINGTONS, University Tutors, 254, Oxford-road, Manchester. Estab. 1876. Ex.

MISCELLANEOUS

FACTORY STORES.
A VERY CONSIDERABLE SAVING can be Effected in FACTORY STORES by introducing an efficient STORES SYSTEM.
A well-organised store represents reduction in the cost of production and increase in profits.
A simple and effective system suitable to any factory can be installed at a moderate charge by
Mr. J. H. BREE, Expert Factory Stores Organiser, 162, St. Leonards-road, London, S.W. 14. P8350 I

PATENTS

THE PROPRIETOR of LETTERS PATENT Nos. 127,248, relating to FUEL AND LIKE PUMPS; "127,249, relating to "ATOMISERS FOR LIQUID FUEL ENGINES;" 127,250, relating to "LIQUID FUEL ENGINES;" 127,251, relating to "TWO-STROKE LIQUID FUEL ENGINES;" 173,221, relating to "IGNITION DEVICES FOR INTERNAL COMBUSTION ENGINES;" 173,222, relating to "COMBUSTION CHAMBERS FOR INTERNAL COMBUSTION ENGINES;" 173,223, relating to "INTERNAL COMBUSTION ENGINES;" 173,224, relating to "FUEL INJECTING DEVICES FOR INTERNAL COMBUSTION ENGINES;" and 146,495, relating to "TWO-STROKE LIQUID FUEL ENGINES," DESIRES to DISPOSE of his PATENTS or to GRANT LICENCES to interested parties on reasonable terms for the purpose of EXPLOITING the same and ensuring its full commercial development and practical working in this country.—Inquiries to be addressed to
CRUIKSHANK AND FAIRWEATHER,
65-66, Chancery-lane,
London, W.C. 2. 4376 H

THE PROPRIETOR of BRITISH PATENTS Nos. 135,362 and 130,551, both dated January 10, 1919, relating to "Improvements in Machine for Forming Hairpins or Similar Articles," and "Improvements in Machine for Counting and Arranging Hairpins or like Forked Articles," respectively, is DESIROUS of ENTERING into ARRANGEMENTS by way of LICENCES or otherwise on reasonable terms for the purpose of EXPLOITING the above patents and ensuring their practical workings in Great Britain.—All inquiries to B. SINGER, Steger Building, Chicago, Ill. 4377 H

THE PROPRIETORS of the Following PATENTS are DESIROUS of ENTERING into ARRANGEMENTS with Manufacturers for the GRANTING of LICENCES or for the SALE of the PATENTS:—

No. 142,847/18, granted to Richard Walter, for "Improvements in or relating to Alloys of Silicon with Metals of the Iron and Chromium Groups."

No. 143,558/19, granted to Richard Walter, for "Method of Producing Alloys Containing Silicon with Metals of the Iron and Chromium Groups."

No. 24,132/13, granted to Heinrich Christiansen, for "Improvements in Apparatus for Use in Tamping or Packing Ballast Under Sleepers of Railways."

No. 103,619/16, granted to Heinrich Christiansen, for "Improvements relating to Pneumatically Operated Percussion Tools."

No. 130,121/17, granted to Heinrich Christiansen, for "Improvements relating to Tamping Apparatus for Use on Railways."

No. 23,223/13, granted to Karl Steinbecker, for "Improved Self-igniting Method and Apparatus for Operating Internal Combustion Engines."

No. 17,798/13, granted to Karl Steinbecker, for "Improvements in Means for Supplying Fuel to Internal Combustion Engines of the Type in which Ignition Takes Place Without the Extraneous Assistance of an Igniting Device."

No. 153,313/19, granted to Gewerkschaft Emscher-Lippe, for "Improvements in or relating to Coking Plants."

All communications in the first instance should be addressed to BREWER and SON, 23, Chancery-lane, London, who will be pleased to forward copies of the Patent Specification to those interested, on request. P8445 H

December 13th, 1923.

PATENTS.

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For continuation of For Sale Advertisements see page 3

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A Seven-Day Journal

375 Miles an Hour.

THE Paris correspondent of the *Morning Post*, in a message published in that journal's issue of Monday, reported that a French inventor, M. Melot, had devised a new type of aeroplane which was shortly to be tested and which was expected to develop a normal speed of 375 miles an hour and a maximum speed largely in excess of that figure. The machine, it was stated, had very thick wings, and would be propelled, not by an ordinary engine, but by a "reaction motor." This motor was described as a trumpet-form of apparatus using fuel, other than petrol, which, when transformed into gas, would be used to expel rearwards through trumpet valves the air drawn in at the front of the machine. "Put briefly," the correspondent wrote, "the new aeroplane appears to work on a somewhat similar principle to that of the fish, which breathes in water through the mouth and forces it out through the ears, thereby developing a propulsive force." Our contemporary's correspondent has certainly discovered a new type of fish, but his account of M. Melot's aeroplane, except as regards the trimmings, appears to have been forestalled in our own pages. M. Melot's "Propulseur-Trompe" was presented to the French Minister of Inventions in May, 1918, and was exhibited at the Paris Aviation Show of January, 1920. A photograph of it was reproduced, and a brief account of it given in our issue of January 16th, 1920, while in our issue of February 20th in the same year, M. Melot, in a letter to the Editor, himself gave further details of its theory and construction. It should be unnecessary to add that on no occasion have we been responsible for suggesting that the speed of a machine fitted with this form of prime mover would reach such a figure as 375 miles an hour.

Shipbuilding Employers' New President.

AT the annual meeting of the Central Board of the Shipbuilding Employers' Federation, held in Edinburgh on Thursday of last week, Mr. Grant Barclay was elected President following the end of Mr. Leonard Ropner's year of office. Mr. Barclay, a native of Port Glasgow, served his apprenticeship with Messrs. Caird, of Greenock, and in succession held appointments with Edward Withy and Co., Hartlepool, the Sunderland Shipbuilding Company and Harland and Wolff. Returning from Belfast to the Sunderland Company's employment as works manager, he finally migrated to Dundee as managing director of the Caledon Shipbuilding and Engineering Company, Limited, a position which he still holds. Mr. John Barr, of Vickers Limited, has now become senior Vice-president of the Federation, and Mr. John T. Batey, of R. and W. Hawthorn, Leslie and Co., Limited, has been elected to the vacant junior vice-presidency.

Glasgow and American Steel.

AT a meeting last week of Glasgow Corporation, the Tramways Committee reported that it had received offers for the supply of special trackwork from the following named firms:—The United States Steel Products Company, £8568; Hadfields, Limited, £9794; Edgar Allen and Co., Limited, £9867; and the Titan Trackwork Company, Limited, £10,031. The Committee, by a majority, recommended the acceptance of the lowest—the American—tender, but the Corporation, as a whole, held otherwise. While some members supported the Committee's recommendation, others thought that the contract should be divided among the four firms that had tendered for it. Others, again, argued that it should be split up among the three British tenderers, and yet others urged that it should go to the lowest British offerer. Eventually, after two divisions had been taken, the latter alternative was decided upon, so that the whole of the contract will be placed with Hadfields, Limited.

Anglo-Persian Oil Company and the Government.

PRESIDING at the general meeting of the Anglo-Persian Oil Company on Monday, Sir Charles Greenway, referring to the possibility of the Government selling its shares in the company and thereby abrogating its control, stated that he was not in a position to give any definite information on the subject, but that he understood that no decision in the matter had yet been arrived at. In this connection, we notice that the Motor Legislation Committee, a body the constituents of which include the Automobile Association and Motor Union and the Society of Motor Manufacturers and Traders, is protesting strongly against the disposal by the Government of its shares in the company. The Committee urges that the retention of the Government's holding is essential in order to safeguard the liquid fuel supplies of the Navy, Air Force, and motor transport interests and to maintain adequate reserves of fuel in this country. It also urges that the surrender of Government control of the Anglo-Persian undertaking would be detrimental to British users of motor spirit, and would result in an end being put to an arrangement which is held to be a safeguard against monopoly. It adds that every effort should be made to encourage the development of the oil refining industry in this country. Apart from the Scottish shale oil refining works, the only petroleum refinery at present in established operation in this country is the Anglo-Persian Company's Llandarcy establishment at Skewen, near Swansea. Something has been heard of the institution of similar works on the lower reaches of the Thames, but so far nothing definite has been reported concerning the active carrying out of such a proposal.

The New Director of Naval Construction.

IT is understood, although so far no official announcement on the subject has been made, that when Sir Eustace Tennyson-D'Eyncourt vacates the post of Director of Naval Construction at the end of this year, he will be succeeded in that office by Mr. William John Berry. Mr. Berry joined the Royal Corps of Naval Constructors in 1887, four years or so after its formation by the late Sir William White. In 1907 he was appointed Chief Constructor at Malta Dockyard, and in 1911 was in the running for the Chief Constructor's post at the Admiralty in succession to Sir Philip Watts. Sir Eustace Tennyson-D'Eyncourt, then chief designer at Armstrong's Elswick works, received the appointment instead, and Mr. Berry was made Senior Assistant Designer, or, as the post has been called since 1917, "Director of Warship Production." With Sir Eustace he took a prominent part in the construction of the immense fleet of battleships, cruisers and other vessels added to the Navy during the war period.

London's Water Supply.

FROM the review of the Metropolitan Water Board's work during the year ended on March 31st last, which has been published since our last issue, we learn that the total volume of water supplied during the twelve months was 88,881 million gallons, or a daily average of 35.07 gallons per head. The latter figure shows a decrease of 1.20 gallons, as compared with the quantity registered in the previous year. It is still, however, high relatively to the consumption per head in provincial centres, but the Board apparently acquiesces in it on the ground that the conditions existing in the Metropolis necessitate a relatively higher consumption than in other parts of the country. It is of interest to note that the month of maximum average daily supply was June in the Western and Southern districts and May in the Northern and Kent districts. The month of minimum average daily supply was April. The variation in the daily average quantity supplied between the months of maximum and minimum demands was 26.633 million gallons. The Board now possesses 48 reservoirs for unfiltered water, the capacity of which aggregates 12,907 million gallons, or sufficient for 53 days' supply.

James M. Dewar.

On Monday evening last a complimentary dinner was held at the Hotel Victoria in connection with the retirement of Mr. James M. Dewar from the London office of Cammell Laird and Co., Limited. Under the chairmanship of Mr. W. L. Hichens, there were gathered more than two hundred guests representing every branch of the shipbuilding and marine engineering industry, and the presence of such a company was itself a striking witness to the high esteem and warm friendship which Mr. Dewar commands in all branches of his profession. Replying to the toast of his welfare and future success, which was proposed in warm terms by Lord Morris and seconded by Sir James Kemnal, the guest of the evening touched upon some of his experiences as a marine engineer. Mr. Dewar is an Ayr man, and served his apprenticeship on the Clyde. He was early appointed to the staff of Maudslay, Sons and Field, and while with that company had much to do with the introduction of the Belleville type of water-tube boiler for marine and naval work. His association with his present firm dates back nearly twenty years to the days of the parent firms of Charles Cammell and Co., Limited, and Laird Brothers, and during this period he has figured prominently in the many successful enterprises which his firm has undertaken in connection with the British and foreign navies and the mercantile marine. During the war Mr. Dewar rendered conspicuous service in connection with the organisation and carrying out of repair and refitting work, munitions and the supply of materials. Few men we know are more intimate with present-day needs as regards shipbuilding and marine engineering, and we feel sure that the fullest success will attend the work which in the coming year Mr. Dewar will undertake.

The London, Midland and Scottish Railway Orders.

THE London, Midland and Scottish Railway Company is making progress with the placing of the orders for material which were outlined on this page of our issue of October 26th. Steel rails to the value of £1,000,000 have been ordered from rail makers, who will get their material from the Clyde, South Wales, Cumberland, Cleveland, Sheffield, and the Potteries. Mineral wagons to the value of another million pounds have been requisitioned from wagon builders, and these orders will find work not only in the areas just named, but in the Birmingham, Gloucester, and Lincoln districts and in Lancashire. Messrs. Vickers announce that they have received an order from the same company for seventy locomotive boilers to be built at Barrow. The London, Midland and Scottish Company intends, Mr. Arthur Watson has just informed us, to spend fourteen millions in labour and material. Four millions are to be devoted to expenditure in the company's workshops in overtaking arrears, in the construction of and repairs to locomotives, carriages, wagons, &c., and in the replacement of machinery. The other ten millions will be spent outside on locomotives, rolling stock, steamers, road motors, boilers, machinery, tools, &c., and in new works, strengthening of bridges, increased sidings, more station and warehouse accommodation, alterations to engine sheds, and at docks.

Railways in the Irish Free State.

Two Bills, one promoted by the Government and one by the Labour Party, to deal with the railways in the Irish Free State, were introduced in Dail Eireann. The former proposed compulsory amalgamation and the latter sought nationalisation. The Labour Party's Bill came before the Dail last week and was rejected by 56 votes to 16. The debate was of interest because of the intimation by Mr. Cosgrove that the Government has now taken a waiting attitude. It apparently appreciates that as long as some companies, *e.g.*, the Great Northern of Ireland and the London, Midland and Scottish, have lines in the Free State and under the Northern Government the whole of the railways in the Free State cannot practically be legislated for. Mr. Cosgrove, therefore, announced that these companies must be consulted, and further, that the regulation of the boundary problem was an essential condition precedent to any final arrangement of the railways. We would add that the situation to-day is that the Great Southern and Western has accepted the terms of the Midland Great Western for its absorption. They both want the Dublin and South-Eastern to join them, but that company would prefer to be amalgamated with the Great Northern. The last-named, having its more valuable portion in the north, cannot readily move in the matter.

The Imperial Air Transport Company.

IT has now been officially announced that Sir Herbert Hambling and Major J. W. Hills will join the board of the Imperial Air Transport Company as the Government directors as soon as that company has been satisfactorily floated and after its shares have been allotted. Sir Herbert Hambling is deputy chairman of Barclay's Bank and served as Finance Member of Council at the Ministry of Munitions during the war. In January of this year he was appointed to the chairmanship of the Civil Air Transport Subsidies Committee, in accordance with the findings of which body the Imperial Air Transport Company is being formed. Major J. W. Hills was Financial Secretary to the Treasury in Mr. Bonar Law's Government. He was for a time a member of the Ministry of Munitions Council and has been a director of the Midland Railway.

The Gyro-Pilot.

THE Cunard liner Laconia, which left New York for Liverpool on Thursday of last week, is the first British steamer to be equipped with the Sperry gyro-pilot. The vessel was expected to arrive at Liverpool to-day (Friday) after her first trip across the Atlantic with the gyro-pilot installation at work. The arrangement, it will be recalled, was shown by the Sperry Company at the recent Shipping and Engineering Exhibition at Olympia, and was illustrated and described in our issue of September 7th. The automatic helmsman, or gyro-pilot, is operated by means of a trolley through which direct contact is established with the card of a repeater compass, an arrangement rendered possible by the high directive force possessed by the Sperry gyro-compass. When the vessel is on her set course, the trolley bears on an insulated sector, but immediately she moves off it, this sector moves from beneath the trolley, a circuit is completed, and a motor operating the steering wheel comes into action. The equipment is provided with means whereby a variable amount of yawing can be allowed for without the automatic pilot actuating the helm. The Laconia is also equipped with the Sperry automatic course recorder, whereby the course followed by the ship and all the deviations therefrom are recorded to scale on a chart. The Laconia is further equipped with wireless direction-finding equipment, but except for the fact that there is a repeater compass in the wireless room, there is no direct connection between the direction-finding and the compass equipments. Such a connection, however, it is permissible to anticipate, may be a development of the near future, for the steering of a vessel automatically by the agency of the wireless direction-finding signals is an obvious development.

Experimental Researches on Propeller Cavitation.

No. IV.* (*Conclusion*).

IN spite of the conflicting theories which we have indicated regarding the phenomenon of cavitation—and, to some extent, the principal ones are more apparently antagonistic than really so—it is by no means difficult to formulate a comprehensive theory as to its inception, development and consequences, and also, to a broad extent, to allocate some relative degree of importance to each contributory factor; but it is virtually impossible to assign very definite values to each on account of the multiplicity of the interactions and reactions which occur underneath a vessel's stern. No single theory of the several hitherto expressed is at all adequate to meet the many varying conditions which exist in practice, and the soundest scientific method of endeavouring to obviate the occurrence is to attempt to formulate the conditions which require to be met—and these can be fairly definitely stated—and then, in the course of a design, to endeavour to avoid trespassing, as far as possible, in any direction on the danger zones. Cases naturally arise in which, for the sake of other advantages, some slight degree of cavitation may be risked, but as long as it is limited to the reduction in pressure forward of the screw created merely by the suction action of the blades causing the air or other gases entrained in the water to be freed and to concentrate in the vicinity of the propeller, the falling off in the propulsive coefficient—unless, of course, the pressure reduction is considerable—will not be very serious. What is to be guarded against is, first, the presence of blunt terminations and their proximity to the leading edge of the screw, which result in cavities in their immediate wake, and which are aggravated by the suction action of the propeller, which necessarily extends to some distance ahead: and, secondly, the sucking down of air from the surface. This latter action is general, and is difficult, if not impossible, to avoid when starting from rest, as can be observed in almost any type of ship; but it seems to be more common than is generally thought to be the case when the vessel is in motion, though it is then very difficult to observe with any degree of certainty owing to the turbulence of the water surface. Under certain circumstances—in very clear warm waters abroad—it can be seen distinctly. Based on a critical survey of the various views put forward at different times, the following definition and description appears to correlate the causes governing the production of cavitation generally in a manner with which serious disagreement can hardly be entertained. While it is indisputable that each one of the separate factors on which previous theories have been based will all cause more or less acute cavitation if pushed to excess, its appearance may be created at a much earlier stage if two or more causes act in conjunction, while equally so its inception may be considerably delayed if adequate regard be paid to all the elements tending towards its production.

Whatever cause or causes may occur to occasion it, cavitation is the rupture of the column of water acted on by the propeller. This rupture may occur before the water reaches the screw or in its passage through the gaps between the blades. Rupture of the column, whether in advance of or in the screw itself, depreciates the reaction otherwise obtainable from it because it reduces both the mass of water passing through the screw and also the velocity which can be impressed on it relatively to still water. The reasons for rupture are complicated, numerous and varied, but they all result in failure to obtain the utmost return from the power delivered to the propeller. Slight rupture will cause a comparatively small reduction in propeller efficiency; serious rupture causes a very sudden drop therein.

Ignoring entirely the performance of models in a tank, wherein gravity and the atmospheric head disturb the law of comparison, imagine a vessel to be propelled by a screw carried well clear of the ship on a shaft projecting from the bow and situated so far ahead that the hull remains unaffected by the slip stream. The vessel is tried under perfect conditions at various increasing speeds, which we will assume to range over percentages of some designed normal maximum, say, V knots. At low speeds—$V \times 0.3$, $V \times 0.4$, $V \times 0.5$, &c.—the propeller, if properly selected for V knots, is too large for the work involved. Granted a well-made, well-polished, sharp-edged and well-radiused design—even if situated in the normal position behind the stern with ample direct supply of water—the losses in that screw will be (*a*) due to slip, and (*b*) those due to blade friction and edgewise resistance—which latter defy precise analysis into their respective elements. These losses vary in proportion as the revolutions and the speed increase. At first the slip will be low, and the blade friction relatively excessive; the slip will gradually increase and the blade friction diminish in proportion with increments of speed until the two become more nearly equal in amount. The thrust per unit of disc area will increase approximately as the square of the speed. This thrust is due partly to suction on the forward face of the blade, and partly, and to a somewhat lesser extent, to pressure on the after face. Now, there is a considerable quantity of air or water vapour entrained in sea water, and quite a slight degree of tension on the water will cause these air particles to expand, with the result of reducing its density, i.e., the weight of water passing through the screw with each revolution, the effect increasing rapidly with increase of tension. If stationary sea water in bulk in an enclosed tank be subjected to the action of an air pump, it will be seen that expansion of this entrained air begins to take place when the pressure is reduced by about 5 lb. to 6 lb. per square inch, and that it increases rapidly as the pressure is still further reduced. This effect is accentuated by non-uniformity of rate of rotation, such as inevitably occurs with reciprocating engines, and variation of resistance due to the position of the revolving blade. Similarly, to a smaller extent, pressure on the blade face expresses the entrained air into the spaces between the blades and into the race column, thus aggravating the influence of the suction from the backs. The extent of these influences naturally depends on the proportions of the propeller and other circumstances—for the moment we are only concerned with the development of the action of cavitation.

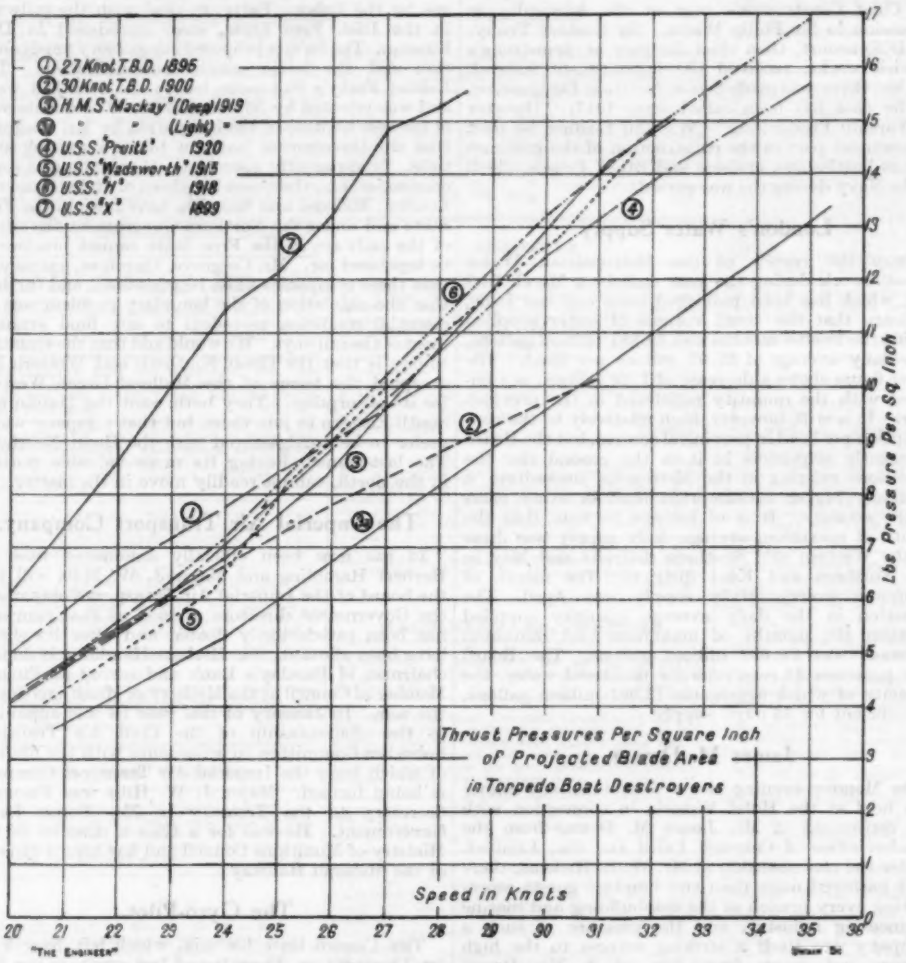

① 27 Knot T.B.D. 1895
② 30 Knot T.B.D. 1900
③ H.M.S. 'Mackay' (Deep) 1919
③ " " (Light) "
④ U.S.S. 'Preitt' 1920
⑤ U.S.S. 'Wadsworth' 1915
⑥ U.S.S. 'H' 1918
⑦ U.S.S. 'X' 1899
Thrust Pressures Per Square Inch of Projected Blade Area in Torpedo Boat Destroyers
Lbs Pressure Per Sq Inch
Speed in Knots
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
"The Engineer"

FIG. 8—CURVES OF THRUST PRESSURES

These bubbles are not vacuum cavities at all, and no approach can be obtained to a perfect vacuum in the presence of so much entrained air. Commencing in the form of minute globules in the water filled with air or water vapour, as the intensity of the thrust increases so does the size and persistency of these formations gradually increase, always more marked the nearer to the surface of the water as the head of water retards the formation lower down, until a relatively stable or permanent stage is reached in which the vacuous cavities merge into one another and become of considerable extent. The earlier phase represents the approximate limit to which a propeller can be driven without incurring any other loss than that due to slip and blade friction: the second stage marks the commencement of the falling off of increments of thrust with increase of torque, gradual at first and increasing rapidly as the cavities enlarge.

If the action of the screw did produce a nearly perfect vacuum in these cavities, then the falling off in thrust would be slight: atmospheric pressure on the surface of the water would force in an adequate supply; but the fact that these cavities are filled with air vapour or other gases partially counteracts the atmospheric effect and leaves the mass of water flowing through the screw largely reduced in consequence. Now, assuming the vessel to be run far above the normal speed—say, at $V \times 1.1$ or $V \times 1.2$ knots, were such a condition possible—the screw would first have expanded the small vapour cavities, then these would merge into larger ones which take up fairly definite positions on the back of the screw blades—depending on the shape, thickness, &c—and, finally, air is sucked down from the surface. This is the worst condition that can occur with any screw because it limits the amount of the natural force causing the water to flow into the screw to the head of water above and not to head plus atmospheric pressure which last item, of course, until an immersion of 33ft. is reached, is the major influence.

The head above a propeller is equal to the atmospheric pressure on the water plus the weight of water per cubic foot, so that, at the surface, the pressure is 14.7×144 lb. per square foot, and at 1ft. immersion, as one cubic foot of sea water weighs 64 lb., it is

$$1 \times 64 + 14.7 \times 144 = 2181 \text{ lb. per square foot.}$$
$$= 15.2 \text{ lb. per square inch.}$$

If then the thrust of the propeller at this immersion exceeds 15.2 lb. per square inch, the water is unable to flow with sufficient rapidity to maintain contact with the blade and a cavity will form between them. The air in the water expands and cavitation gradually commences long before a pressure nearly approaching 15 lb. is reached. As the water flows towards the blade, its velocity increases and the pressure falls in the relationship of $\frac{V^2}{2g} = \frac{P}{64}$, and at 12in. immersion, or $P = 2181$ lb., the velocity of flow at which zero pressure occurs is 46.7ft. per second. As long as the velocity is less than this the pressure is positive; if the velocity exceeds it, the pressure becomes negative in value. If air is sucked down, the overwhelming majority of the atmospheric pressure is removed and the velocity of influx is then limited to the head due to the weight of water, or about 8ft. per second. Experience has shown that somewhere between 12ft. and 18ft. per second, depending on whether reciprocating or turbine-driven propellers are in use, constitutes a region beyond which the water supply will begin to fail badly.

In attempting to allocate relative degrees of importance to the causes of cavitation, it must be understood that the following conditions are common to all cases:—Aeration of water, barometric pressure, condition of blade surface, density of water, immersion of blade tips and temperature of water. Granted these, then undoubtedly unimpeded flow of water to the screw in as perpendicular a direction to its transverse plane as possible, is of primary importance. Rake of shaft finds no expression in any of the theories, yet its influence on the pitch of a screw is very considerable. When the rate angle approaches the exaggerated figure of certain recent work, the screw may cavitate over one sector only—that is, when the blade is descending past the horizontal centre line—and, conversely, it may easily develop negative slip on the opposite position as the effect of

* No. III. appeared December 14th.

rake is to increase the pitch of the descending blade and reduce that of the ascending one. This seems to afford one of the explanations of the low-propulsive coefficients of some of the later British torpedo-boat destroyers, where the shaft angles ran from 4.5 to 5 deg. from the horizontal. The results of H.M.S. Mackay are a case in point. It seems fairly obvious that a screw cannot possibly exert its model tank standard of efficiency when it has to suck against a flow of water arriving at one angle to its axis and discharge it at another; when the difference between the normal, maximum and minimum face pitch due to shaft rake may be 1.0, 1.26 and 0.76, as it was, approximately, in the Mackay near the blade tips. Local pressure conditions, and pitches, especially on the trailing edge of the inner portions of the blade backs, then become entirely different from what they are when the screw is working on its normal axis. And yet we are invited to express surprise that the relative rotative efficiency is in the region of 0.85!

In high-speed craft, where absolute velocities through the water of 50ft. to 60ft. per second—30 to 36 knots—are common, it is inevitable that large holes—not small cavities—must be torn in the water in the immediate wake of shaft brackets with blunt terminations or large transverse radii connecting arms and bearing boss, and which give a most unshapely section through the plane of attachment. These holes persist aft of their generating point into the transverse plane of the propeller edges, and in the past were often responsible for erosion as the blades slammed into them each—for there are two arms—at the rate of a dozen or more times a second at a velocity of anywhere between 60ft. and 240ft. per second with direct connected turbines. With any serious shaft rake, and it is difficult to get below 3.5 deg. with twin turbines situated athwartships, the presence of the bearing boss aggravates this tendency to break up the water in front of the screw, and the consequent emulsion surrounding it is accentuated by the tension on the water from the screw preventing the closing of these holes under the head above them. Loss of mass flowing through the disc is inevitable from this cause. No better instance of this effect can be given than in the case of several of the 300ft. 1070-ton United States destroyers, in which the lower arm of the A bracket—which was a horizontal one—was inclined downwards at the forward edge by 4½ deg., in order that, when the vessel was running with the trim due to full speed, this arm would pass horizontally through the water. Between 22 knots and about 27 knots, when the trim angle created the latter position, this bracket arm dragged very badly indeed, causing a very considerable region of broken water in the neighbourhood of the screw, and at about 24 knots causing a reduction in propulsive efficiency of from 61 to 57.5 per cent. Details of this are given under vessel "G" by Admiral Dyson, U.S.N., in a paper read to the American Society of Naval Architects in 1920, from which it is very clear that cavitation must be considered from the external point of view as well as merely from that of the screw alone.

For the latter only, the separate main factors liable to create rupture of the thrust column are, it would seem, in order of importance:

(i.) Speed of water flowing through the screw in relation to still water.
(ii.) Thrust per unit of area—disc or projected.
(iii.) The section of the blade in association with its speed of travel through the water and the relative angle of advance.

Important, but entirely subsidiary, factors are:
(iv.) Irregularity of turning moment.
(v.) Contour of blade.
(vi.) Number of blades.

Any appreciable reduction of the mass of water acted on by the propeller necessitates the use of greater power in order to obtain a relatively increased speed of slip in order to produce the desired thrust, *i.e.*, the product of mass × velocity, and, hence, the propulsive efficiency deteriorates.

It may be said that between the rupture of the column due to speed of slip, or to thrust per unit of area, there is no really substantial difference, but the analysis of very numerous trials of vessels fitted with different types of machinery—reciprocating engines, direct-connected turbines, geared turbines and oil engines—certainly does tend to show that the limitation of speed of real slip is a much more rigid boundary line than that of thrust pressure per unit blade area. In Fig. 8 a series of thrust pressures for a number of torpedo craft is shown. The pressures for Mackay and Pruitt were actually recorded by thrust meter. Those for U.S.S. Wadsworth and "H" and "X," are based on Washington E.H.P. figures for hull and appendages, as are also those for the British 27 and 30-knot vessels, except that the E.H.P. for the latter was obtained at Haslar. The curve for vessel "X"—see Dyson, Am. Soc. N.A., 1920 shows an extraordinary high range of thrust—23.7 square feet of total projected area for 9300 indicated horse-power and 28.5 knots is, obviously, extraordinarily low, and the propulsive efficiency in this case was very poor, being less than 0.50 for E.H.P. with appendages. The suggested limit of 13 lb., as given by Mr. Barnaby, also seems too low. U.S.S. "H" was a sister ship of Pruitt, but driven by direct-connected turbines, the propellers being 7ft. 9.6in. in diameter by 7ft. 5½in. pitch, with P.S.R. 0.65, against Pruitt's 9ft. 2in. by 10ft. 2in. by 0.55 P.S.R. Dimensions and displacement were identical, but for 35 knots "H" required 29,400 shaft horse-power, with 655 revolutions, against Pruitt's 27,600 and 442 revolutions. The respective propulsive coefficients were 0.55, against Pruitt's 0.599, the E.H.P. being that including appendages.

The real reason in the case of very fast craft for preferring speed of slip as a criterion to the danger zone to pressure lies in the fact that in many cases, especially in the case of recent United States destroyers, there is a tangible amount of negative wake, and under this condition thrust alone is not an accurate measure. Again, as is emphasised in the Mackay and Pruitt comparisons, very particular care was taken in the latter vessel to obtain a flow of water as nearly perpendicular to the screw disc as possible, whereas in the Mackay the shaft rake was 5 deg., and the shape of stern was not nearly so suitable for obtaining direct flow to the screws as it was in the case of Pruitt. Temperature of water exercises quite an appreciable influence on permissible thrust. At 80 deg. Fah. the pressure of water vapour is 0.5 lb. per square inch; at 60 deg. it is 0.255 lb.; and at 35 deg. Fah. it is 0.1. Thus between a high barometer pressure in the Arctic or a low one in the tropics, the effect on permissible tension is material. Again, there is often a good deal of loose thinking or talking about pressure. Figures are given regardless of immersion, or ignoring the method of determining the pressure. In Fig. 8 data does not permit of correcting the curves to 12in. immersion as a standard, and no surprise need be occasioned if figures of 18 lb. to 20 lb. per square inch are quoted in some cases. Thus in some of the earlier U.S. Dreadnought type battleships, with small direct-driven screws, working from the E.H.P.—with appendages—actual pressures as high as these figures have been obtained, the head of water above the screws being about 14ft. to 15ft. Such a figure corrected for immersion becomes about 12 lb. at 12in. immersion. Again, if the hull efficiency exceeds unity, that is to say, if the thrust horse-power is less than the effective horse-power, the actual pressure based on E.H.P. undergoes a further reduction in the ratio of the hull efficiency to unity, or *vice versâ* if the hull efficiency is less. Another argument against the use of pressure alone as a criterion is the fact that determinations of effective horse-power, unless properly made, are apt to be extremely erratic. It is true that in estimating the speed of real slip, which is $(P \times N)-(V-W)$ where P = pitch, N = revolutions, V = speed of ship, and W = speed of wake, all in feet per second, we do not know *exactly* what the pitch is, and are dependent on the tank for the value of the wake, but these factors are less liable to distortion than is the figure for thrust. If the thrust be worked out from the thrust horse-power formula—see Part II.—the speed of advance being taken from tank data estimated, very surprisingly high figures will often be found. Destroyers frequently show apparent pressures exceeding 22 lb. or 23 lb. under such circumstances, and if the propeller were so immersed that cavitation could not occur, this would be the figure which the screw should develop on the basis of the model enlarged. As it is, cavitation, either incipient or aggravated, prevents the attainment of these figures and the efficiency falls off.

Now the efficiency of a screw is written

$$\frac{\text{Thrust} \times \text{travel per revolution}}{\text{Turning moment} \times 2\pi}$$

and as far as precision is concerned, the only figure upon which no doubt can be cast is the 2π. The thrust is very seldom measured indeed, and in spite of the facilities now available it really is extraordinary that more effort is not directed towards determining, if only on trial, precisely what it is. For sea service work it would probably prove more valuable still. Mr. Baker states bluntly that the discrepancy between service voyages and tank results is virtually impossible to bridge with the data available, but this is not all. The travel per revolution is far from being exactly known because the wake is not susceptible of direct measurement. *Accurate* torsion meter readings at sea are very rarely available; they are not always reliable on trial. What, then, becomes of the efficiency formula in the case of ship trial analyses? In a tank it is a different matter. Accuracy of observation is then possible within extremely small margins, and the losses in the screw are capable of determination. The minute, however, that any rupture of the water column passing through the screw occurs the tank efficiency is not reproduced, and we have shown a dozen causes why this rupture may occur.

Again, as regards the use of thrust alone as a criterion for cavitation, it should be noted that Mr. Barnaby did not use his figures as absolutely binding. For motor ships with irregular turning moments, quite a low pressure—8 lb. to 9 lb. per square inch—is suggested, and thus we get a range of 8 to 16, the latter as seen in Fig. 8. No such divergence can be considered in the case of speed of real slip. With reciprocating engines a figure of 12ft. per second is certainly a danger zone, and in the cases of some of the early turbine destroyers of the Tribal classes, speeds of 24ft. were not at first uncommon. In these latter, however, cavitation was very serious, and subsequent trials with larger screws brought this figure down considerably. In the reciprocating engined cruisers trouble occurred with speeds of 13ft. per second. Too much emphasis must not be laid on one particular item. Cavitation is a comprehensive matter, and can be caused—perhaps created would be a better term—well within any of the limits put forward by any single element of abnormality. And it must also be understood that although limits of, say, 16ft. and 16 lb. are permissible together in torpedo craft, 10ft. and 10 lb. are not to be approached with high efficiency in single screw work. Much higher speeds and pressures are permissible behind fine lines than behind full ones, yet nothing of this is to be discovered in any of the itemised suggestions for the occurrence of cavitation hitherto propounded. The case of propeller tips revolving in too close proximity to a vessel's hull is suggested as one cause for cavitation. This is by no means certain. The idea perhaps had its foundation in the local vibration effects in the Lusitania and Mauretania in the vicinity of the propellers; but it would appear likely that it was not the propeller that was robbed of water owing to inadequate flow, so much as that as each blade passed the point nearest the hull, the centrifugal action of the water escaping over the blade tips from the pressure to the suction side of the blade caused a momentary hammer blow on the ship's plating. This vibration was nullified by a change in number of blades from three to four and by the adoption of a contour with sharper tips than had been adopted in the three-bladed design. Sharply shaped tips are liable to induce excessive local pressure if the mean pressure over the blade be high.

In the analysis of ship trials there is still a great deal to be done. There is the question of ascertaining from trial results not only the degree of the suitability of the screw, but also of the form of hull and, in many cases, what has been regarded as the breakdown of the propeller should not have been blamed so much on the screw at all, as on the fact that the form of hull was not entirely suitable for the maximum speed obtained. Merely to plot the curves of data obtained on a progressive trial is quite insufficient; complete analysis of performance at each separate speed is required. A very good instance of what might, at first sight, have appeared from a mere inspection of the trial figures and curves to be a serious breakdown, occurred in the trials of the U.S.S. Wadsworth, the first U.S. all-geared turbine destroyer. Designed for 29.75 knots, she obtained 31.7 on trial. At 30 knots the apparent slip curve ran up rapidly from 20 to 24.5 per cent. at the top speed, and, apparently, a serious drop in screw efficiency was involved. Analysis, however, showed that this was not the case. The form of hull was quite suitable up to the designed speed, but the resistance above 30 knots augmented very rapidly, and the extra resistance was responsible for the flexure in the slip curve. It was overcome, however, with very little drop in propulsive efficiency, a value of 0.579 being obtained at 29.8 knots and 0.567 at 31.7, with thrust pressures per unit of projected blade area rising from 12.48 to 14.35. The curves alone are useless for exposing the presence of cavitation due to the action of the screw, and only very complete analysis will afford the requisite information.

But to enable this to be accomplished—and this, in fact, means to enable designers to learn what exactly is going on in the way of component losses between the power and the resistance—adequate and accurate data are essential. The former are as necessary as the latter; in the case of the Mackay, the results were taken at about 20, 26 and 31 knots on the deep load trial, and 21, 27.5 and 34 on the light trial, or a gap of 12 knots, roughly, with only one observation in between them! This trial would hardly have been of interest had it not been for the provision of thrust meters. As to the all-important question of accuracy, errors of observation are only too frequent. They are very difficult to eradicate, and only the greatest care and thoroughness will ensure that a trial is not rendered almost futile from the scientific point of view owing to lack of accuracy in taking the essential records. It is only then that closer approximations between the model and the ship results can be made with any degree of certainty.

Links in the History of the Locomotive.

By E. A. FORWARD.

No. II.*

THE exact date of Seguin's first engine is to be found in an official report quoted in "Hommes et Choses du P.L.M." This report shows that the first experimental trial was made on November 7th, 1829, on a short piece of line, 40 m. long, laid in the railway workshops at Perrache, which was the Lyons terminus of the railway. Steam was raised in thirty-six minutes and the engine manœuvred for an hour, drawing a load of 19 tons up an incline steeper than any of those on the railway itself. It will be observed that this trial took place two months after the Rocket had been

* No. I. appeared December 14th.

tried at Newcastle, and one month after the Rainhill trials.

This trial is also mentioned in a report on the St. Etienne Railway published in the *Bulletin Industrielle* of St. Etienne in 1830, which gives the additional information that the test incline was 14 in 1000, and the speed on it was 4.5 miles an hour. The middle section of the line, between Givors and Rive-de-Gier, 16 kiloms. in length, was to be opened in the spring of 1830—it was actually opened in October—and on it the engine drew 24 tons on a slope of 6 in 1000 and 45 tons on the level. This same report, speaking of the anticipated reduction in haulage costs, says :—

"This reduction in costs is due to a new locomotive made by M. Seguin, which is much better than those which came from England. The new engine cost 10,000f., weighs 6000 kilos. (5.9 tons), and produces 882 lb. of steam per hour. The English engine cost 16,000f., weighed 9500 kilos. (9.35 tons), and produced only 772 lb. of steam per hour. The chimney, which was too high for the tunnels, has been shortened, and two fans have been applied to produce the necessary draught. The boiler is mounted on springs."

This is believed to be the earliest account giving any particulars of Seguin's engine, but, if the figures given are correct, the evaporation of his first locomotive boiler was at that time little better than that of the English engines, and only one-third of that he obtained with his experimental boiler, so that the engine could hardly be described as satisfactory.

m. Delivery pipe from the pump.
n. Pump chamber.
o. Casing for leading the products of combustion into the tubes.
p. Fan moved by the steam engine.
q. Fan blades.
r. Communication with the furnace.
s. Fire-place.
t. Ashpan receiving air from the fans.
u. Chimney.

"The space between the tubes is occupied by the boiling water and it covers them to a depth of from 2in. to 4in. When feeding the boilers of steam engines, if we introduce cold water, it results in a sudden lowering of the temperature, which stops the production of steam and thus the engine, which is a very serious inconvenience. This can be remedied by introducing hot water into the boiler, but if the means of heating this water is not regulated it may happen that the water arrives at the feed pump boiling ; it then forms steam in the space *n*, which, balancing the atmospheric pressure, forces back the water into the reservoir, so that the pump ceases to feed, although its piston continues to work. To prevent this inconvenience I have placed in the body of the pump a valve *h*, which opens when the piston rises and closes when in descending it reaches the water below it. In the ascending movement of the piston any steam which may be in the pump escapes through the piston so that the pressure inside cannot be greater than that of the atmosphere. On the down stroke the valve remains open, releasing the vapour, until when it reaches the water it closes and forces the water into the boiler.

"The steam arrives in the reservoir *c* after having served in the cylinders, but this detail has not been put in the figure, since it is foreign to the object of the patent, which applies to the case where the water in the reservoir *d* is heated in an entirely different manner than by the steam."

We now come to the illustrated description of Seguin's engines by Messrs. Schlumberger and Koechlin, which appeared in their report to the Société Industrielle de Mulhausen on a journey undertaken by them to examine the new patented system of boilers by M. Seguin and Co. at St. Etienne. The reports says :—

"The object of the design is to produce a small boiler with a large heating surface and to produce a draught without the aid of a chimney. The boilers which we have examined produce steam for locomotives at a pressure of 3 atmospheres.

"The locomotive has a furnace 4ft. 3in. long and 2ft. 5.5in. wide placed between two double walls of sheet iron filled with water and communicating with the interior of the boiler. At the end of the fireplace is a cast iron hollow wall, also filled with water, and this communicates with the boiler and is fixed to it. The grate is composed of two rows, each of 17 bars, placed one behind the other. The boiler is a cylinder of sheet iron and its lower half is traversed longitudinally by 43 small tubes, through which the hot air passes before escaping outside. The whole, with the water, weighs 3000 kilos. Finally, there are two fans, which force the air into the fire-place, which is entirely closed at the front, with a pressure high enough to establish a good draught and a very intense and complete combustion. For the better understanding of the boiler tubes and fans two plates are given." (The drawings on these plates are reproduced, with some modification, in Figs. 3 to 6.)

"Two carriages, connected by means of a hinged iron bar, serve to support the engine, boiler and everything depending on it. One of the carriages is furnished with a wooden framework resting on flat springs, on which is placed the boiler, the furnace and flue, and has on its two sides the steam cylinders, the feed pump and everything composing the engine. On the other carriage are the two fans, which communicate by pipes with the lower part of the fireplace, the water tank and a place for the coal and an attendant. The weight of the whole engine is 6000 kilos. and the price 10,000f.

	Square metres.
"Heating surfaces of the boiler—	
Boiler cylinder	2.56
Fire-box sides and end	.90
43 tubes	15.78
Feed-water reservoir	1.95
Total	21.19

= 228 square feet."

The drawings show side and end elevations of the engine, a side elevation of the tender, and longitudinal and transverse sections of the boiler. The description accompanying them is as follows :—

"A. Boiler of the machine.
B. Fireplace.

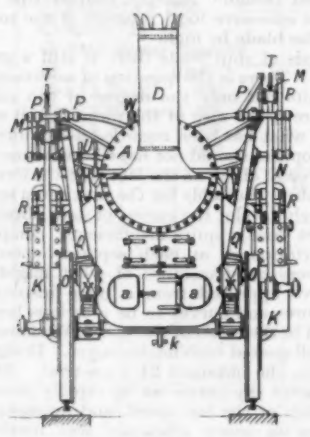


Fig. 3.

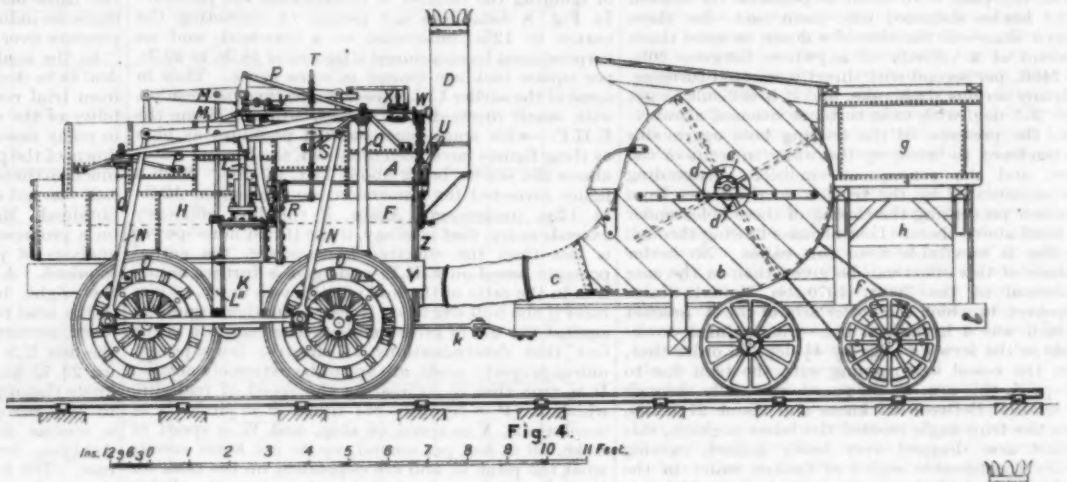


Fig. 4.

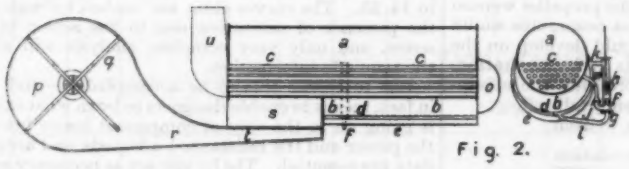


Fig. 2.

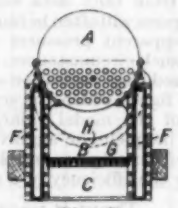


Fig. 5.

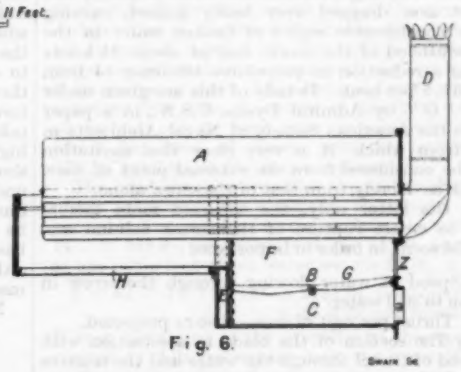


Fig. 6.

"The Engineer" Sheets Sc

THE SEGUIN MULTITUBULAR LOCOMOTIVE

a. Boiler.
b. Passage for the hot air.
c. Tubes receiving the hot air.
d. Reservoir for the feed water.
e. Space for the steam for heating the water in *d*.
f. Feed pump.
g. Suction valve.
h. Valve in the piston.
j. Delivery valve.
k. Pipe connecting the upper side of the piston with the feed-water reservoir.
l. Pipe doing the same for the lower side.

C. Ashpit.
D. Chimney.
E. Hollow cast iron casing at the back of the fireplace communicating with the interior of the boiler and with
F F. Two other hollow cast iron casings placed on the two sides of the fireplace.
G. Grate.
H. Semi-cylindrical hollow casing communicating on one side with the cold water reservoir by a leather pipe, and on the other with the boiler feed pump.
I I. 43 small copper tubes through which the smoke passes before arriving at the chimney.
K K. Steam cylinders of the locomotive.
L L. Piston-rods.
L". Feed pumps for the boiler.
M M. Wrought iron double beams which communicate with the wheels by means of connecting-rods.
N N. Connecting-rods.
O O. Wheels carrying excentric pins which form the cranks on which the connecting-rods work.
P P. Wrought iron guides forming the parallel motion.
Q Q. Cast iron columns supporting the journals of the guides at each side, united by fixed iron bars.
R. Movement of the slide valves.
S. Ring fixed to the working beam which gives an up-and-down motion to the rod T at each stroke of the piston.
U U. Levers to move the valves by hand so as to make the engine go in whichever direction is desired.
V. Double cock admitting steam equally to the two cylinders and which can be regulated by the bar W.
X. Safety valve.
Y Y. Two strong oak beams forming the base of the engine and fitted with spring-supported cast iron boxes in which the axles of the wheels turn.
Z. Cast iron plate closing the front of the furnace and having openings *a*, through which the air from the fans passes to the ashpan.
b. Casings of the fans terminating in nozzles *c*, which communicate with the openings *a* by flexible leather pipes.
d d. Fans with four blades.
e. Pulleys fixed on the fan shafts.
f. Pulleys fixed to the carriage wheels to give motion to the fans by means of belts.
g. Water reservoir.
h. Space for the coal.

k. Flexible coupling by which the fan carriage is attached to the locomotive.
ll. Chains by which the wagons are attached behind the fan carriage and engine.
m. Flap valves for shutting off the fan pipes.

"The water reservoir is square and of sheet iron, so that the quantity of water leaving it could be accurately measured. The boiler is provided with glass tubes to indicate the water level, so that it was easy to measure the quantity evaporated. The boiler is unlagged. The diameter of the piston is 9.06in. and the stroke 23.6in. The steam pressure is 3 atmospheres above the external pressure, and the engine makes 60 revolutions per minute. To each boiler there are two fans, 64in. diameter, which receive their movement from pulleys on the wheels when the engine is moving. When the fire is started a man turns the fans by hand. The four fan blades have iron arms having at their ends thin boards 12.75in. wide and 14.9in. long. They make normally 300 revolutions per minute and produce a current of air equal to a pressure of 0.63in. to 0.79in. of water, a speed which is only obtained with high and good chimneys when the air on entering has besides a temperature of 400-500 deg. Cent."

Visitors who witnessed some experiments on the engines noted that when both the fans were working they burned 100 kilos. of coal per hour and evaporated 785 kilos. (1730 lb.) of water per hour, an evaporation nearly twice that obtained in Seguin's first locomotive trial, but still far behind that of his experimental boiler. This figure is almost up to the Rocket's later figure of 1870 lb., but far inferior to that of the Arrow, one of the Liverpool and Manchester engines immediately following the Rocket, which showed an evaporation of 2750 lb. per hour.

The engine hauled a load of 29.5 tons on a gradient of 5.7 in 1000 at a speed of 4.5 miles an hour, while on the level it could haul 70 tons. These results are somewhat better than those obtained on the first trial on the railway, in 1829 or 1830, but are not superior to those obtained with the old four-wheeled engines on the Stockton and Darlington and other English railways. It must be remembered that in cutting down the weight of his engines Seguin also reduced the maximum tractive force that could be obtained; moreover, the recorded experiments do not show any realisation, in his own engines, of his hope to secure increased speeds by means of his tubular boiler.

When we examine the drawings of Seguin's locomotive boiler it will be seen that it differs considerably from the ordinary form, and this difference probably accounts for its inferior performance as compared with the experimental boiler. The barrel was 31in. diameter and 9ft. long, but the fireplace, instead of being placed at the end and leading directly to the tubes, was arranged below one end of the barrel, the hot gases passing along underneath the barrel and then returning through the tubes; this was obviously a less efficient arrangement than the normal one. The sides of the fireplace were formed as water spaces 2.5in. wide, but their only communication with the boiler barrel was by means of the transverse bridge casting at the front. There could thus have been little or no circulation in these side walls. The drawing shows the walls of cast iron 0.75in. thick and they are unstayed, but the first part of the report mentions sheet iron sides and gives larger dimensions for the grate than those of the drawing, which are 4ft. 1in. long and 2ft. 3in. wide, giving a grate area of 9.2 square feet. The ratio of heating surface to grate area was 24.8, which is about the same as that of the Rocket. The differences mentioned may be accounted for by the reporters having seen at least three engines which perhaps differed in details. The flue leading from the fireplace was formed by a double sheet iron casing which served as the feed-water heater and was at the hottest part of the boiler. In the 1830 patent drawing an exhaust steam chamber surrounds the feed-water heater, but in the engine this was omitted. The tube ends appear to have rings or nuts outside the tube plates, but no longitudinal stays are shown. A weighted lever safety valve is fitted, and a hinged door is provided at the base of the chimney. The section of the boiler does not show the plates and joints of the barrel.

The engine had four wheels, 44in. diameter, on a wheel base of 4ft. 10in. The wheels had cast iron naves and wooden spokes and felloes surrounded by plain iron bands on which the wrought iron flanged tires were fitted. Two flat iron rings, one on each side, were bolted to the spokes at about mid-length, and the crank pins were fixed to these. The gauge of the rails was 4ft. 6in. The framing consisted of two longitudinal beams, 9in. by 5in., and the axle-boxes were fastened to stiff plate springs which were bolted directly up to the underside of the beams.

The cylinders were placed 5ft. 7in. apart, one on each side, low down between the wheels; they were each supported by a flange resting on the frame beam, while there appears to be a flanged web secured to the side of the fireplace also. The piston-rods projected upwards, their ends being guided by parallel motions, the radius rod pivots of which were mounted on cast iron pillars standing on the frame and stayed at their upper ends by rods bolted to the boiler. Each piston-rod had a horizontal beam, equal in length to the wheel base, pinned to its head, and from the ends of this return connecting-rods descended to the crank pins on the wheels, which were also coupled by a rod. The valve chests were on one side near the upper ends of the cylinders and the valves were driven by tappet rods actuated by the crossheads, spring buffers being fitted to the tappets to minimise shocks. Hand levers were provided for reversing. The regulator and steam inlet pipes are clearly shown, but there is no sign of an exhaust pipe in the drawing. Possibly the exhaust steam was passed directly into the feed heater, as suggested in the 1830 patent. The feed pump is bolted to the side of the cylinder and its plunger is driven by the crosshead. The tender with its fans needs no further description.

It is interesting to note that Biot, in 1834, says that in the St. Etienne engines they had preferred to suppress the excentrics (which were presumably used on the Stephenson engines) and to move the valves by a tappet motion. In the Conservatoire Nationale des Arts et Métiers at Paris there is a model of Seguin's engine, to a scale of 1:6, which was presented to that institution by M. Augustin Seguin, a son of Marc Seguin, in 1891. This model is believed to have been made for the donor some few years before that date; it resembles the Mulhouse drawing, but differs in some details, so that it is unlikely to have been made from them.

At the end of Seguin's book of 1839 is a list of the parts of his locomotives, which he thought would be useful to persons similarly placed to himself. It gives detailed costs of an engine on the model of those sent from England. The total cost amounted to 14,320f. and the price of a tender on Stephenson's plan was 1000f., but this form of tender had been superseded by a more commodious, stronger, but more expensive tender. The actual cost of his engine was therefore considerably more than the 10,000f. previously claimed for it, and was even more than the 12,500f. said to have been paid for the English engine. In the list of parts of the boiler is a very interesting indication as to how the tubes were secured; these items are:—

	f.
83 bouilleurs en cuivre jaune	1740
Façon desdits pour soudage	180
Soudure forte et rondelles pour ajustage	50
Tournage des tuyaux aux deux boute..	63

From this it would appear that the ends of the tubes were turned and fitted with external rings which were hard soldered to the tubes and tube plates. By this time also the fans had been abandoned and the valves were driven by excentrics.

Seguin concludes his account by saying:—"The vertical cylinder arrangement does not lend itself so well to rapid movement as do the latest engines which have been made by various constructors. In these the cylinders are placed horizontally under the boiler and the movement is communicated directly from the piston-rods to cranks on an axle to which the driving wheels are fixed. This simplifies the mechanism, but the results, considered relatively to the amount of work obtained, and to the cost of transport, do not differ very much. The two systems are employed concurrently on the St. Etienne Railway."

Then follows a table giving the work done by the locomotives then on the line, from May 1st to October 1st, 1838. From this it appears that there were twelve engines with vertical cylinders and four with horizontal cylinders. The former differed in the number of their boiler tubes, some having only forty-three and others as many as eighty-two. The average work done by the vertical engines was slightly less than that done by the horizontal engines, but the coke consumption of the former, for a given amount of work, was less than that of the latter. From the particulars in this table it is probable that the Mulhouse drawing refers to engine No. 3, while the price list refers to the last of the type, No. 12, which had apparently only just commenced work.

It will be seen, then, that Seguin was not the first to invent a multitubular fire-tube boiler, nor was he the first to apply it to the locomotive. His own locomotive boiler was evidently not an unqualified success, as in the form used it does not appear to have given the results expected of it. The fact that twelve of the engines were made, however, indicates that they were good enough for the coal traffic on the St. Etienne Railway, but they were probably soon superseded by engines of the normal type, of which four were on the line in 1838. There is, however, reason for believing that the later vertical-cylinder engines had boilers of the Stephenson type.

Seguin has been called, rather inaptly, the French Stephenson, for after making the St. Etienne-Lyons Railway, which established the family fortunes, he concerned himself no more with practical engineering, but devoted the remainder of his life to purely scientific studies. He did not seek honours, but was made a Chevalier of the Legion of Honour in 1836, and an Officer of the same in 1866; he also became a member of the French Institute in 1845. In 1887 it was proposed to erect at Annonay a statue in his honour as the inventor of the tubular boiler, but this proposal has only just been carried out. Such a statue was, however, made for the P.L.M. Company, and stood for a time at the Gare de Lyon at Paris, but has now been removed to the company's offices.

IT is reported from Australia that one of the largest oil seepages yet discovered in that continent has been found at Sassafras in the Mersey Valley.

Institution of Mechanical Engineers.

THE view was commonly expressed that the paper presented last Friday evening before the Institution of Mechanical Engineers by Professor A. H. Gibson and Mr. H. W. Baker, of Manchester University, entitled "Exhaust Valve and Cylinder Head Temperatures in High-speed Petrol Engines," was one of more than ordinary practical value. In spite of its being very largely a record of experimental data, in spite, too, of the narrow field which, to judge by its title, it covered, the opinion was expressed—and we share it—that the authors had succeeded in presenting a mass of valuable information bearing very directly on the design of high-speed internal combustion engines at many important points.

Elsewhere in this issue we begin a reprint of the paper in abstract, but in order that the discussion may be made more intelligible to our readers, we give below a note of the general conclusions at which the authors have arrived:—

The investigation goes to show that, in a well-designed and well-cooled overhead valve petrol engine, either of the air-cooled or water-cooled type, under normal conditions of operation, the temperature of the exhaust valve may be between 600 deg. Cent. and 750 deg. Cent. The temperature is affected by a large number of factors, the most important, in an engine operating without detonation, being the timing of the ignition, the temperature of the cooling water, and the strength of the working mixture. The highest temperatures under such conditions are attained at full throttle with the weakest mixture capable of maintaining maximum load, with the highest jacket water temperature, and with a retarded ignition.

In a given cylinder with different compression ratios, so long as the power being developed is constant, the exhaust valve temperature at a given horse-power is sensibly independent of compression ratio.

If, owing to some such hot spot in a cylinder as may be produced by the action of a loose valve seat or of a defective sparking plug, pre-ignition is set up, the temperature of an exhaust valve may readily attain temperatures exceeding 800 deg. Cent. At such temperatures the valve, whether of chromium or tungsten steel, will rapidly burn out. At lower temperatures chromium steel has the advantage of not oxidising so rapidly as tungsten steel with weak mixtures, although at temperatures not exceeding 750 deg. Cent. both are capable of giving excellent results.

The best shape of valve head appears to be one having a flat bottom and a tulip-shaped top. Owing to the weight, this is in general impracticable, and the next best is one having the tulip-shaped head common in aero-engine practice. Increasing the lift of the valve within limits tends to cool operation by reducing the mean scouring velocity of the gases.

Within the limits usual in practice, tappet clearance does not greatly affect valve temperatures. Even negative clearance, so long as this does not exceed about 0.010in., has only a small effect. Generally speaking, the conditions tending to give a hot valve also tend to give a hot cylinder head. The result of retarding the ignition is exceptional in that it gives a hot valve but a cool head. The range in head temperatures corresponding to a given change in operating conditions is, however, much smaller than the range of temperatures of the exhaust valve.

Valve temperatures are sensibly the same, whether petrol is used as a fuel or a petrol-benzol mixture. In this connection benzol is only of real advantage under conditions in which the use of petrol would be accompanied by serious detonation leading to pre-ignition.

By water cooling exhaust valves the temperature can be reduced to about 300 deg. Cent., and such valves enable the output and efficiency of an engine to be appreciably increased. They also enable a higher compression ratio to be used. They are, however, only suitable for use on an air-cooled engine, and if water is used as the cooling fluid, unless carefully designed, are likely to prove a source of danger.

Professor Gibson, having presented an interesting and illuminating summary of the paper, Mr. W. A. Tookey was called upon to open the discussion. Mr. Tookey remarked that as the paper was mainly a statement of the results of research work, and as the figures recorded in it were above all criticism, it was hardly possible to discuss it in the usual way. There remained, however, the possibility of comparing the authors' results with those obtained by other engineers working in a similar field. Such a comparison, he said, he had made by means of a diagram which he exhibited showing a series of curves compiled from the authors' test results and from other sources. In this diagram—see Fig. 1 on page 664—the abscissæ represented mixture strength expressed in terms of British thermal units per cubic foot of the total cylinder volume, while the ordinates represented the ratio of the brake mean effective pressure to the mixture strength. The diagram showed that it was possible to compare the small high-speed petrol engines tested by the authors with such radically different forms of internal combustion engines as a 1600 brake horse-power two-stroke Nobel-Diesel engine, such as that described in THE ENGINEER for January 27th, 1922, and a modern cold-starting heavy oil engine with a compression pressure very nearly equal to that of a Diesel engine. He suggested that the method of comparison indicated by the diagram should be adopted as a common basis, and that the authors' use of the air-petrol ratio as a measure of mixture strength was open to criticism. In general, he thought the diagram showed very clearly that there was a limiting mixture strength in all cases, which gave the best results.

Mr. Tookey has since furnished us with the following detailed explanation of his diagram:—

The chart is based primarily upon mixture strength in terms of heat units per cubic foot of total cylinder contents. This quantity is readily calculable from test results as usually presented, as, from the rate of fuel consumption per unit of time, a simple calculation based upon cylinder dimensions of the engine and the number of working cycles determines the mean strength of mixture per cubic foot of cylinder volume. Therefore with a knowledge of the compression volume ratio the strength of mixture can be expressed in terms of so many B.Th.U. contained in 1 cubic foot of total cylinder volume; that is, piston displacement plus clearance—the horizontal scale of the chart.

The vertical scale is the ratio between pressures developed by

the combustion of the mixture within the engine cylinder and the mixture strength as above explained. The pressure is in terms of pounds per square inch, and when divided by the strength of mixture gives the "Tookey factor" of efficiency. The latter thus connotes so many pounds of mean pressure developed for each B.Th.U. contained in a cubic foot of the working mixture.

Comparison of test results on the Tookey factor value enables the performance of all kinds of internal combustion engines to be compared on a standard basis, as it provides for cylinder dimensions, compression volume ratios and all other variables.

Dealing with the curves on the chart, the straight line marked 1 represents the data given in the paper in connection with the tests of the air-cooled cylinder, Fig. 1 (a)—see page 675. It will be seen that all the test results follow a straight line law and that the strength of mixture being used in this particular series of trials ranged from about 60 to 90 B.Th.U. per cubic foot, the efficiency falling off with the higher mixture strengths.

The curve marked 3 refers to the data given in the paper in connection with the tests of the air-cooled cylinder, Fig. 2. It will be seen that it runs parallel to curve No. 1, except for three peculiar tests, and the reason for this is explained in

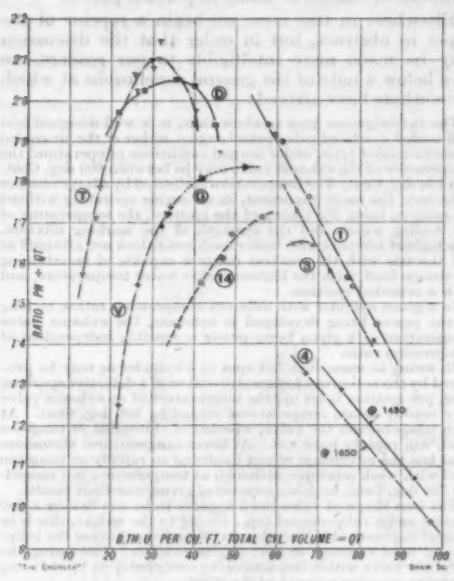


FIG. 1

Professor Gibson's paper as being due to the position of a sparking plug. Reference to the paper itself will make this clear.

The curve marked 14 is plotted from information deduced from data given in the paper in connection with the tests of the modified Armstrong-Siddeley water-cooled engine and relates to the performance of the engine when run under test at 1680 revolutions per minute with a volume ratio of 4.92. This test was made with water-cooled cylinders, whereas those noted by curves 1 and 3 refer to air-cooled cylinders. The peculiarity of the curve 14 is that with increasing mixture strengths the efficiencies are increased, whereas the converse is true of curves 1 and 3.

Curve 4 relates to the air-cooled cylinder shown in Fig. 4 of the paper. It would appear that, other things being equal, the speed at which the engine was operated had something to do with the relative efficiency when compared on the basis of the mean strength of mixture.

In order to compare Professor Gibson's results with the work of others, and in particular with other types of internal combustion engines, curve V has been plotted, which represents the efficiency line on the Tookey factor basis of a six-cylinder National gas engine. The prolongation of these plotted points by curve G is interesting, as curve G is drawn through points which refer to the results obtained by Professor Gibson (and reported to the Institution some years ago) when conducting experiments with a single-cylinder National horizontal gas engine. The characteristic of curves V and G is again increasing efficiency with increase of mixture strength, but, as will be seen, the latter is at its maximum at about 50 B.Th.U. per cubic foot.

Curve T refers to a liquid fuel engine of the cold starting type,

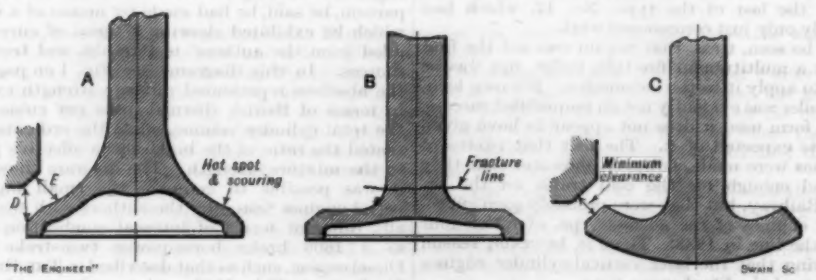


FIG. 2

plotted from a test made on a Tangye cold-starting heavy oil engine. Again the characteristic is increase of efficiency with increase of mixture strength, the maximum mixture strength for maximum efficiency being round about 30 B.Th.U. per cubic foot.

Curve D refers to a test of a Nobel-Diesel engine, four cylinders, two stroke, tested by Professor Rosburg, of Stockholm, in 1921. This engine is of 1600 horse-power capacity, whereas the Tangye engine was of 70 horse-power. It will be seen that, probably due to the constant volume cycle rather than constant pressure cycle, the rate of change in the efficiency curve is much less, indicating that the chief difference between the two cycles—namely, the relative timing of fuel injection—does affect the efficiency very materially at loads other than full load.

It will be realised that the Tookey factor based on mean pressures on the brake horse-power basis does not represent the true ratio of work produced per heat unit contained in the mixture. This ratio can only be obtained from a knowledge of the mean pressures on the indicated horse-power basis, and it is, no doubt, on this account that the maximum point on curve D is lower than the maximum point on curve T, as undoubtedly the resistances of the Diesel type with its air compressor are more than the resistances of the cold starting Tangye engine, and it can therefore be expected that the ratio $P_m \div Q_t$ would be more nearly equivalent than the ratio $P_n \div Q_t$.

Colonel L. F. R. Fell, of the Air Ministry, referred to the authors' statement "that, generally speaking, it was inadvisable to fit sparking plugs either directly adjacent to or directly opposite an exhaust valve." In view of the experiments, he, Colonel Fell, had carried out on an engine with an 8½in. bore cylinder, he was inclined to agree with that view. The experimental engine referred to was fitted with three sparking plugs, one on the exhaust side, one on the inlet side of the cylinder, and a central plug. When the plug on the inlet side was switched in a definite falling off in horse-power was obtained and detonation was produced. There was no doubt that the central plug was best. In the section of the paper dealing with spark advance, the authors had shown that for all compression pressures, the lowest valve temperatures, and the highest powers and the minimum petrol consumptions were obtained with the spark as fully advanced as possible without causing detonation. Should not the word "detonation" be replaced by the word "pre-ignition"? If detonation were produced by advancing the ignition it would seem to show that either the compression was too high or that the fuel was unsuited to the compression and the type of engine cylinder. Ordinary advanced ignition would give a looped diagram. When using alcohol as a fuel it was practically impossible to obtain detonation by raising the compression. He had found that with compression ratios of 7 : 1 the only effect was that pre-ignition set in, but detonation did not occur. Reference had been made to the falling off in horse-power obtained when an inclined sparking plug was used instead of a horizontal one. The alteration in plug position was a small cause to produce such a large effect as that indicated by the authors' figures. He would like further details as to the exact position of the plug.

Figures, he continued, had been given showing the influence of jacket water temperature on the temperature of the cylinder head. Were not some of the low temperatures to be explained by assuming that steam was formed in the cylinder head, and that heat was, as a consequence, abstracted at a high rate to give the required latent heat of evaporation? Another influence was undoubtedly the formation of steam around the valve seats in the inner parts of the cylinder head casting which would impede the cooling water circulation. In some experiments carried out by Mr. Ricardo oil had been used for cooling purposes instead of water. Oil, however, had been shown to be entirely unsuited for such a purpose, for if local heating took place, instead of steam forming—as with water—hard deposits of oil and tarry matter were formed and overheating was encouraged. At the end of one test which was made certain oil fractions were present which showed conclusively that temperatures of over 200 deg. Cent. had been reached. Oil cooling brought about a 15 per cent. reduction in the output obtainable. From his experiments Mr. Ricardo had deduced that air cooling could never be as efficient as water cooling, because of the latent heat abstracted when steam was formed.

The subject of valve design touched upon in the paper was, Colonel Fell proceeded to remark, most important. The ordinary tulip form as shown in sketch A—Fig. 2—was slowly being superseded. True, it was strong and might possibly be pulled through its seat without breaking, but there was a tendency to throttling in the region just above the inner line of the seating, for the area at E was less than the area at D. This part of the valve became hot and scouring took place. Type B was better in shape, but trouble was experienced with fractures at the line marked. A new type of valve shown diagrammatically in sketch C was being introduced. With this valve the minimum clearance for admission was perpendicular to the valve face and a better volumetric efficiency was given. If steam cooling were used it would need to be brought lower down than was the case with the tulip type of valve. The experiments with water-cooled valves, described by the authors, were of interest, but he did not think such valves would be of use for aero engines, because of the small sized valve commonly used with such engines. There would no doubt be a field for their use with larger engines.

Professor E. G. Coker said that the difficulties introduced by the existence of high temperatures in the valves and other parts of internal combustion engines were well known and must increase as the size of the engines increased. The temperatures of the exhaust valves recorded in the paper were, in his view, noticeably high—from 600 deg. to 750 deg. Cent.—and that fact led him to inquire whether the authors in the course of their experiments had experienced any difficulty with pre-ignition. Ten or eleven years ago the late Professor Hopkinson had tried deliberately to produce pre-ignition by introducing into the combustion space of a 40 horse-power gas engine an electrically heated wire, the temperature of which could be measured. He found that with the wire raised to 700 deg. or 750 deg. Cent., pre-ignition was produced to an extent sufficient to stop the engine. About the same time he—Professor Coker—and Dr. Scoble conducted some experiments to investigate the temperatures of the working substance and of the internal parts of a slow-speed water-cooled 10 horse-power National gas engine. By means of thermo-couples it was arranged to measure not only the mean temperature of the different parts, but also the cyclic range through which such temperature varied. It was found that the temperature of the charge after firing was from 1750 deg. to 1850 deg. Cent.—above the melting point of platinum. The mean temperature of the exhaust valve varied from 330 deg. to 390 deg. Cent., and in each test it showed a cyclic change in addition, the total range through which it fluctuated being of the order of 70 deg. Cent. The temperature at the centre of the piston was lower than that of the exhaust valve—from 240 deg. to 350 deg. Cent.—but the cyclic change was greater, being about 100 deg. Cent. In light of the cyclic variation, it might well be that some of the temperatures recorded in the paper might actually imply the existence momentarily of temperatures as high as 900 deg. Cent. It was therefore difficult for him to understand how the engines ran so well as they apparently did.

Professor W. E. Dalby congratulated Professor Gibson on the clear way in which he had defined the objects of his experiments and had attacked the problem in hand. The independent variable was the exhaust valve temperature, and the curves given showed the inter-relation and interaction of the various dependent variables. Other valuable factors, such as the relation of horse-power to speed, had been derived and determined during the course of experiments. It was necessary to try to visualise the main principles underlying the particular problem of heat transmission presented by an internal combustion engine. There were in the cylinder large quantities of heat which flowed across and through the cylinder walls to the outside. The heat was taken up by all the various metal parts in contact with it, which parts were exposed to cyclical temperature variations superimposed on a mean temperature. Professor Gibson had measured one particular temperature in the path of flow, on one stream out of the many extremely complicated systems of heat flow. With the knowledge given in the paper, was it possible to work further and to improve the design of the engine? There was much information to collect, but he felt that a very good beginning had been made. Turning to the conclusions, he commented upon the authors' statement that the highest exhaust valve temperatures were attained at full throttle, with the weakest mixture capable of maintaining maximum load, with the highest jacket water temperature and with a retarded ignition. All these considerations assisted in lowering the temperature of combustion, and as a result the heat gradient establishing the outflow of heat from the interior of the cylinder through the walls, cylinder head, &c., was lowered. Consequently, when the exhaust valve opened there was less thermo-motive force to expel the heat from the cylinder, and, as a consequence, the gas escaping past the open exhaust valve was hotter. In a series of tests he had recently made with a four-cylinder engine of 20 horse-power Treasury rating, the exhaust gas temperatures at loads between 28 and 32 horse-power were found to be about 640 deg. to 700 deg. Cent. The actual valve temperatures were not measured, but the exhaust gas temperatures would seem to agree closely with the figures obtained by Professor Gibson and Mr. Baker. With reference to the kind of steel used for valves, he noted that chromium steel was better than tungsten steel. He presumed that the chromium steel mentioned by the authors was the ordinary stainless steel. [Professor Gibson intimated that it was.] In conclusion, he asked what type of indicator was used for the experiments.

Mr. E. B. Wood expressed surprise at the fact that the exhaust valves and cylinder heads of an ordinary motor car type of engine should reach such high temperatures as those recorded in the paper. In view of such temperatures, and considering that the spontaneous ignition temperature of petrol was about 300 deg. Cent., it was hardly to be wondered at that such engines were very much influenced by small changes in the shape of the combustion space or the position of the sparking plug. He was sorry that the authors had not investigated the effect of a wider range of compression ratios, as by doing so they might have been able to throw direct light on Mr. Ricardo's observation that the volumetric efficiency decreased with the compression ratio, the drop being particularly noticeable between the ratios 6 and 7. The experiments in general seemed to him to suggest the necessity for the increased

development of the sleeve valve type of engine.

Mr. E. R. Dolby gave an account of a piece of practical experience with a large gas engine which convinced him as to one cause of pre-ignition. A large exhaust valve had to be ground in, and to facilitate the operation the attendant drilled a ¼in. tapping hole ¾in. deep into the valve head, which was tapped to receive a handle for the grinding-in operation. On replacing the valve and starting up the engine pre-ignition and detonation took place, with the result that the exhaust chamber was fractured. In his opinion there was no doubt that the sharp edge of the tapped hole was raised to such a temperature that pre-ignition was caused.

Mr. B. B. Low, dealing with the experiments in water-cooled engines, raised the question of valve lift. Theoretically, the maximum lift for a poppet valve was one-quarter of its diameter. For the engine type experimented with the theoretical lift was, therefore, 0.36in. The highest lift mentioned in the paper was, however, 0.312in., and it was found that as the lift was increased up to this figure from 0.215in., the maximum power was increased, the total increase over the range being 3 per cent. What would have been the effect on the power, he asked, if the lift had been increased to the theoretical value? In some recent American experiments it had been shown that the greater the lift—even when the theoretical maximum was exceeded—the greater was the flow. It was, therefore, to be concluded that the theoretical maximum lift was only a geometrical maximum.

Professor P. M. Baker, discussing the authors' investigations regarding the effect of the position of the sparking plug, said that in the Armstrong-Siddeley engine the two plug positions—see Fig. 5 of the paper—were, no doubt, symmetrical relatively to the valves, but they were not symmetrical relatively to the gas flow. The gas flowing down the curved inlet past the valve would, no doubt, retain some of its horizontal momentum, with the result that while the plug which was situated on the left-hand side of the cylinder would receive the full blast of the incoming charge, that situated on the opposite side would be more or less in contact with the burnt products of combustion. Dealing with Professor Coker's point, he said that in his view there was probably but little cyclic variation in the temperatures of an engine running at 1500–1800 revolutions per minute, as the time available for such variations was exceedingly small.

Professor Gibson, in his reply, stated that he wished to have an opportunity of dealing with the various points in writing, particularly those raised by Mr. Tookey. He would, however, deal briefly with some of the questions that had been discussed. Colonel Fell had mentioned the importance of sparking plug position. He agreed that the central plug would probably give the best results, but the engines he had so far tested did not allow of a plug being fitted in that position. With regard to the use of the word detonation in the paragraph cited by Colonel Fell, the word was used deliberately, for, as the spark was advanced, pronounced "pinking" was noticed, and this eventually merged into pre-ignition and pulled up the engine. With regard to the position of the plug in the Armstrong-Siddeley engine, as Professor Baker had pointed out, it was not symmetrical to the inlet gas flow. He felt that the inclination of the plug in the alternative position had something to do with the result obtained, especially when the spark was retarded. Might not the effect be caused by the explosion wave from the plug striking the top of the piston and being reflected to the cylinder head by a longer path? As to the effect of the jacket water temperature, he could not agree that it was mainly due to the steam formed. Thermo-couples placed on the hottest parts of the cylinder head did not register 212 deg. Fah., and it was, therefore, improbable that any steam was formed. Replying to Professor Coker's question as to whether there were no difficulties with pre-ignition, Professor Gibson stated that such difficulties were only experienced when compression ratios greater than 5.2:1 were used. He thought that the high speed of the engine had a favourable influence on the experiments. The engine tested by Professor Hopkinson ran, if he remembered rightly, at a speed of from 110 to 200 revolutions, whereas, of those described in the paper, one had a speed of 1800 revolutions per minute. The indicator used was an American one of the Midgley type. It gave good comparative values, but could not be depended upon for quantitative experiments. A new indicator, of the Watson-Dalby pattern, had now been fitted, and excellent results at speeds up to 2000 revolutions per minute had been obtained.

Institution of Electrical Engineers.

A PAPER on "Pulverised Fuel and Efficient Steam Generation" was read before the Institution of Electrical Engineers on December 13th by Mr. David Brownlie. As a result of a personal inspection of nearly 2000 boiler plants, equivalent to a consumption of 15,000,000 tons of coal per annum, the author's final conclusion is that the average efficiency with which 90,000,000 tons of coal are burnt per annum in the steam boilers of Great Britain is less than 60 per cent., which represents an avoidable loss to this country of no less than 20,000,000 tons of coal per annum. According to the author, there is at present no satisfactory boiler testing code in the world. What is supposed to be the British standard code, that of the Institution of Civil Engineers, is, he says, so hopelessly antiquated and out of date that no one thinks of using it. The codes of the American Society of Mechanical Engineers and of the German Association of Engineers are both much better, but even they are not satisfactory, and the author has suggested the formulation of a new international boiler testing code, an outline of which he has given at great length in his book on "Boiler Plant Testing." The absence of such a code tends to considerable confusion in expressing the results, which may vary 2 to 3 per cent. on this account.

The "Lopulco" system of pulverised fuel, the paper explains, embodies very many refinements and improvements which has made possible the remarkable success that has been obtained. The chief of these is the water screen, consisting of a series of water-cooled 4in. steel tubes in the bottom of the furnace, which prevents "slagging." The brickwork is hollow and cold air circulates through it, and the resulting heated air at 300 deg. to 700 deg. Fah. is then used to supply the 90 per cent. of secondary air to the burners, thus resulting in extraordinary efficiency.

In America there are eight large boiler plants working on the "Lopulco" system, with forty-three water-tube boilers, mostly very large, the total heating surface being 360,130 square feet. With 300,000 square feet in constant operation and conservative figures of 0.75 lb. coal or 6.50 lb. of water per square foot of heating surface per hour, this represents 702,800 tons of coal per annum (7000 hours), and is equivalent to forty-seven standard large British power station boilers of 50,000 lb. evaporation per hour.

There are now under construction on the "Lopulco" system twenty-nine plants, comprising ninety-one boilers, including many of the largest water-tube boilers in the world, having a total heating surface of 1,405,230 square feet. Assuming, as before, conservative estimates, this equals a consumption of 2,695,300 tons of coal per annum; that is, 142 standard 50,000 lb. British power station water-tube boilers in constant operation. In less than six months from now 3,400,000 tons of pulverised coal will be used per annum for steam generation, a consumption equal to half that of the whole of the power stations of Great Britain put together, or sixteen Dalmarnock stations. In Great Britain, however, there has been practically no headway at all, and even at the present time there is only one large boiler plant at work, that of the Hammersmith electricity station, on pulverised coal, with three boilers of 45,000 lb. evaporation, together with a small installation at Peterborough, and one or two odd experimental boilers.

Prior to the experience obtained since 1920, the ordinary admitted advantages of pulverised coal included higher boiler plant efficiency, complete combustion of the ash, the fuel is burned without moisture, convenience of transport in the boiler-house, flexibility as regards different qualities of fuel burned, extraordinary flexibility of the steam output of the boiler, as much as 100 per cent. overload, reduced stand-by and banking losses, greater ease of scientific control, and reduced labour costs. The various disadvantages that have been advanced against pulverised coal, such as excessive power consumption by the crushing, drying and pulverising operations, wear and tear and risk of breakdowns, deterioration of the furnace linings, damage to the boilers, danger of explosion and spontaneous combustion, troubles with the ash, and higher capital cost as compared with mechanical stoking, are now proved—as the result of the experience of burning several million tons of coal—to be almost entirely erroneous in the case of modern plant.

The "Lakeside" plant at Milwaukee is designed for a capacity of 160,000 kilowatts normal, or 200,000 kilowatts overload, and the 40,000-kilowatt boiler plant portion now running consists of eight "Edgemoor" four-pass water-tube boilers, working six, of 13,060 square feet heating surface, with a normal evaporation of 90,000 lb. of water from and at 212 deg. Fah. per hour, or 115,000 lb. overload, equal to 4¾ tons of pulverised coal per boiler per hour normal. The installation includes superheaters and cast iron economisers and works at 300 lb. gauge pressure, with a "Lopulco" water screen on each boiler, with twenty-two tubes 4in. diameter, making 320 square feet heating surface, and the plant is now being doubled in size.

The new plant at Vitry now being erected, the first large modern pulverised coal plant in Europe, consists of four "Ladd-Delaunay-Belleville" boilers of 16,678 square feet heating surface, with steel tube economisers of 9684 square feet heating surface, each boiler having one "Lopulco" vertical coal drier, using the heat in the chimney gases only, one pulveriser, five "duplex" pulverised coal feeders, and ten "Triplex" burners. The normal evaporation is 140,580 lb. of water from and at 212 deg. Fah. per hour, with an overload duty for four hours' duration of 210,870 lb. per hour, representing 5.7 tons normal and 8.8 tons overload coal consumption per hour, the calorific value of the coal being 12,600 B.Th.U. The efficiency guarantee is 84 per cent., 10.98 lb. of water from and at 212 deg. Fah. per pound of coal on normal load, or 10.76 lb. overload, equal to 8.4 lb. and 12.6 lb. of water per square foot of heating surface per hour respectively. The total auxiliary power used is 19½ kilowatt-hours per ton of coal, or 1 per cent. of the steam production.

The Dalmarnock station of the Corporation of Glasgow, which is designed for 200,000 kilowatts, contains at present plant of 75,000 kilowatts capacity, and the boiler plant is composed of sixteen boilers (twelve usually working when on full load) of 6948 square feet heating surface each, with 2452 square feet superheater and 5155 square feet economiser heating surface, working at 275 lb. pressure and 700 deg. Fah. with a normal evaporation of 50,000 lb. from 150 deg. Fah. and 62,500 lb. overload, working, of course, with mechanical stokers.

In comparing the mass of data given, the most striking fact is the extraordinary efficiencies being obtained with pulverised coal. Lakeside is running regularly at 85 to 86 per cent. boiler plant efficiency, the most efficient station in the world, and 89 per cent. has been obtained on ordinary short tests. The loss of heat in the chimney base is only 8 per cent., the unburnt carbon in the ash about 0.5 per cent., and the excess air for combustion over the theoretical 10½ to 25 per cent., depending on the rating.

The guarantee for the Vitry station, as already stated, is 84 per cent.; at the new Cahokia station, St. Louis, the figure is 85 per cent.; and at the Detroit Edison Trenton Channel station, with six enormous boilers of 29,000 square feet heating surface, 86½ to 88 per cent., with 83 per cent. at the extraordinary overload of 13.8 lb. of water from and at 212 deg. Fah. evaporated per square foot of heating surface per hour; that is, no less than 400,000 lb. of water per boiler per hour. Mechanical stoking on water-tube boilers, Mr. Brownlie explains, cannot touch these figures. In Great Britain, the author states, 85 per cent. of water-tube boiler plants are working at less than 70 per cent. efficiency, 10 per cent. at under 65 per cent., and less than 5 per cent. are over 80 per cent. Amongst the finest long-duty performances with mechanical stokers are Dalmarnock (Glasgow), running 76.6 per cent. efficiency on 34 per cent. load factor, and probably 78.5 per cent. on 60 per cent. load factor; and in the United States the Connors Creek plant is 75 per cent., the Colfax power station 76.5 to 78.5 per cent., whilst Delaware is said to be 79.1 to 81 per cent. The best possible mechanical stoker long-duty practice is 81 to 82 per cent. efficiency with 40 per cent. excess air. Pulverised coal, therefore, will give, say, 86 per cent. efficiency and mechanical stoking 81.5 per cent., a saving of 5½ per cent. in the coal bill. Under normal conditions, however, mechanical stoker efficiency is only 75 per cent., so that the saving would be 12¾ per cent., and if pulverised coal was installed on most mechanically fired power stations, British or otherwise, the saving would be 15 to 20 per cent. in the coal bill.

Contrary to what is supposed, the maintenance cost of pulverised coal plant are not excessive, being actually less than mechanical stoking itself. As the "Lakeside" plant, Milwaukee, fifteen months' running showed a cost 1.17 pence per ton of coal in repairs to the plant, and the "Lopulco" guarantee for the air-cooled brickwork is now actually three years, a period which no mechanical stoker can equal. The danger of explosion and fire is not a serious matter, and as regards ash troubles, these also cause little difficulty. Careful tests at Lakeside show that 12 to 25 per cent. of the ash is blown out of the chimney top in an extremely fine state of division, 25 to 50 per cent. falls to the bottom of the combustion chamber, and 25 to 35 per cent. is caught in the chimney base. The labour costs with pulverised coal are approximately 20 per cent. less than with mechanical stoking. At the Lakeside plant, Milwaukee, several years' running shows a labour cost, in equivalent English money, of 1s. 3d. per ton, whereas at Dalmarnock, Glasgow, the figure is 1s. 7d. The total auxiliary power used for pulverised coal is now only 1 per cent. of the steam production of the plant. The very latest stoker performance is slightly less than 1 per cent., but the average is 2 to 3 per cent., and at Dalmarnock is 1.68 per cent. The unburnt material in the ash of pulverised coal is 0.40 to 0.75 per cent. carbon, whereas the best stoker figures are 2 per cent., with 3 to 5 per cent. for a large number of stations.

Other advantages of pulverised coal are the enormous flexibility in the quality of the coal that can be burnt, so that differences in the heating value do not affect the efficiency of the plant, as with mechanical stoking. Also, pulverised coal will work in an extraordinary manner with other fuels, whether blast-furnace gas, coke oven gas, oil, or pulverised coke, whilst the flexibility in evaporation is astonishing, overloads of 100 per cent. being taken with ease for long periods. The stand-by losses are considerably less with pulverised coal, and plants with long banking-up periods show a saving of 3 to 5 per cent. in the coal bill. The ease of scientific control is so remarkable that boilers on pulverised coal can be worked entirely from a distant switchboard by one attendant, as in the case of the Ford plant, Detroit. It is difficult to obtain authentic figures for the capital cost, but, roughly, there is not much difference between pulverised coal and mechanical stoking.

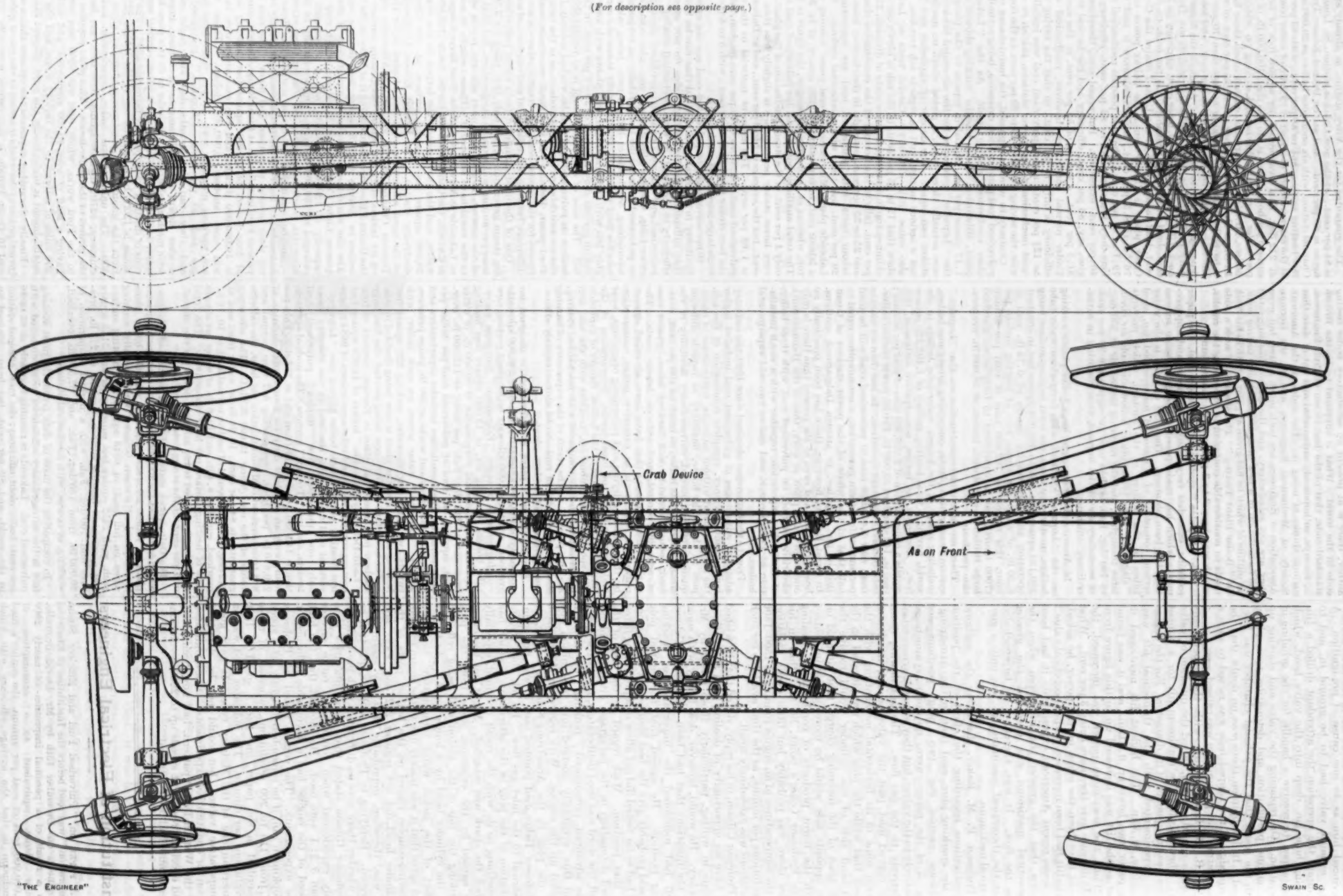
One of the most significant facts about pulverised coal for steam generation is, not only that plant for 3,500,000 tons per annum will soon be in operation, but that many of the newest, largest, and most efficient power stations in the world have adopted it. These include, in addition to Lakeside at Milwaukee and the Ford River Rouge plant at Detroit, the Cahokia station for St. Louis (240,000 kilowatts), and the new boilers, the largest in the world, of 30,000 square feet heating surface, at the Cleveland electricity station. The Detroit Edison Company, one of the most efficient known, has adopted it for the new Trenton Channel station of 300,000 kilowatts capacity on six boilers of 29,600 square feet heating surface; and the Union d'Electricité is installing it at Vitry on the largest boilers in Europe (16,678 square feet heating surface). Also the world-famous Colfax power station of the Dusquesne Light Company, at Pittsburg, which now has a capacity of 120,000 kilowatts, and is at present being enlarged to 180,000 kilowatts, and eventually to 360,000 kilowatts, is adopting pulverised coal for these extensions.

Another significant fact is that stations like those of the Lakeside and the Ford Motor Company are greatly extending their present pulverised fuel plant. The cost of the present Ford installation at River Rouge, Detroit, consisting of four boilers of 26,500 square feet heating surface, is 10,000,000 dollars, and the extensions now in hand will cost another 6,000,000 dollars. These boilers are working normally with 70 per cent. blast-furnace gas and 30 per cent. "Lopulco" pulverised coal, and they run nine months day and night without a shut down, an achievement, of course, impossible with mechanical stoking. In order to do this pure distilled water is used for the make-up, a plant turning out 1380 tons of distilled water per day being installed. The boiler-house is 120ft. high and the top of the boilers 82ft. 9in. from the ground, the combustion chamber alone being 55ft. The units of one boiler, superheater, and steel chimney, 327ft. high, weighing 1000 tons, are hung on the girders of the boiler-house. This plant supplies power to the Ford works, which turn out 6200 cars per day, having a staff of over 40,000 employees, and including 300 miles of railway in the factory alone, and the whole establishment is undoubtedly the most efficient known.

Finally, the author expresses the opinion that a serious investigation of the whole question of the use of pulverised coal in Great Britain is imperative, especially for large power station plant.

THE HOLLE FOUR-WHEEL-DRIVING-AND-STEERING MOTOR CAR

(*For description see opposite page.*)



"THE ENGINEER"

SWAIN SC.

A Remarkable Motor Car.

To be driven boldly across a ditch at a speed of 15 miles per hour or so, and across a heath bordering a road, merely for the sake of passing another car, to take a kerb some 8in. high at 20 miles, to climb a gradient somewhere about 1 in 3, to turn in a circle of 20ft. diameter and to pull up from full speed in three or four lengths, are all rather startling experiences; but when such manœuvres can be carried out on thin mud or wet grass without inconveniencing the passengers, it seems to us that the car merits the adjective we have applied to it in the title of this article. The car with which we had these noteworthy experiences a few days ago is the invention of Mr. A. A. Holle, who has offices with Mr. B. Haydn White at 30, Norfolk-street, Strand. It is illustrated technically by the accompanying drawings and by the three half-tone engravings on this page, whilst some other illustrations are presented on page 670 to give the reader an idea of the vehicle's capabilities.

We gathered, in conversation with the inventor, that one of the first things which led him to consider the general design of his car was a glimpse of an approaching vehicle that showed how the front axle was constantly being tilted one way or the other by inequalities of the road surface. These inequalities do not, except in very unusual circumstances, affect both the wheels on one axle simultaneously; yet, with the normal arrangement, every time any one wheel runs over an obstacle the whole unit represented by two wheels, their axle, &c., has to be moved and a corresponding shock is transmitted through the springs to the chassis. Mr. Holle concluded from this observation that each wheel ought to be attached independently to the framework, so that whilst there would be an absolute minimum of unsprung weight, each wheel would be able to accommodate itself to inequalities of the road without affecting the others. In this way, the inventor argued, the road-holding qualities of the car would be improved, and it would be possible to drive comparatively light vehicles over rough surfaces without loss of control. Consideration was also given to the fact that the ordinary back axle drive is unstable, as the propelling force tends to accentuate any deviation from a straight path and induces side-slipping. Finally, there is a minor objection to the ordinary Ackermann system of steering, in that it causes a car to turn about a centre in line with the back axle, while the rear wheels travel round curves inside the track of the front wheels, so that the centre of gravity of the car moves more or less sideways and another cause of skidding is introduced.

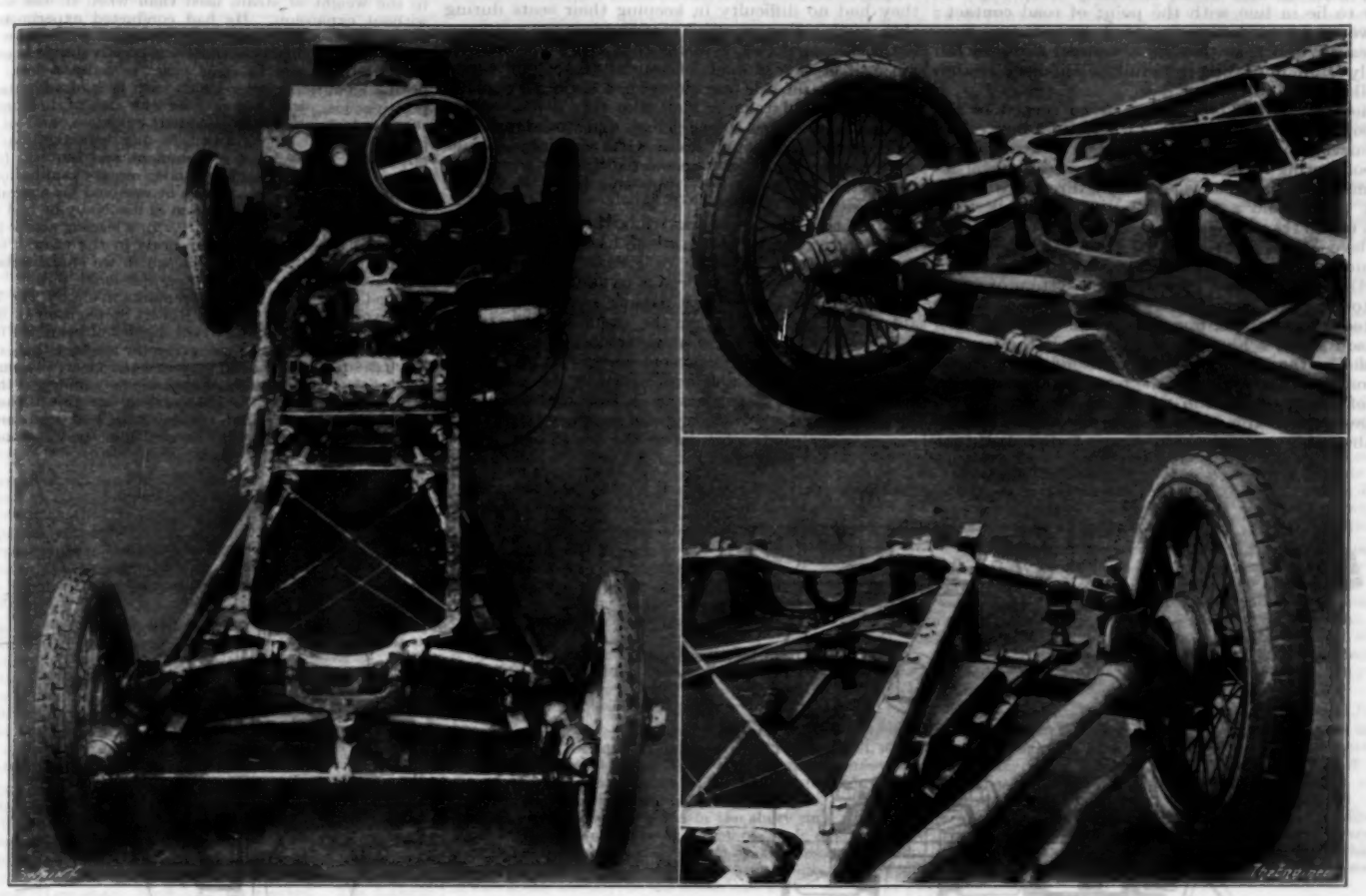
As a result of considering all these factors it was decided to make all four wheels exactly similar in all their functions. Although this radical departure from orthodox design has been made, it is noteworthy that the car does not look freakish and at a few yards distance is hardly distinguishable from others, a matter of some importance from the selling agent's point of view.

The method of connecting the wheels with the framework is plainly shown in the line drawings on page 666. Each wheel is mounted on a short stub axle, and this axle is anchored to the chassis by two A frames, placed one above the other and separated by a distance of 8in. or so. One leg of each A lies transversely across the car, while the other leg points towards the centre. All the links forming these A frames are jointed at their ends, so that the whole system forms a kind of parallel motion which allows the stub axle to rise and fall vertically with respect to the chassis, but holds it rigidly in other directions. In order to support the weight of the car four long cantilever springs are fixed to the main frame and attached by sliding connections to the upper links of the A frames.

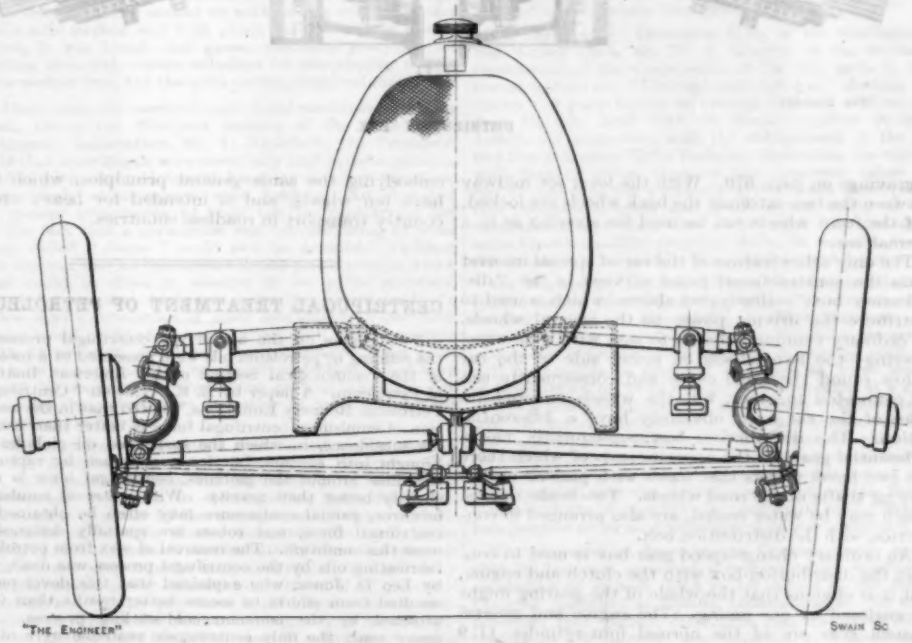
An interesting experiment is being made in connection with the springing system, but was not in operation on the occasion when we inspected the car. The centre abutment of each spring is fixed in a slide with roller bearings, so that the active length of the spring may be varied. The abutment is connected with a hydraulic ram which is supplied with oil under pressure by a pump driven by the engine. A regulating device is introduced into the circuit so that the rams are subjected to an oil pressure corresponding to the speed of the engine. The rams act against coiled springs and consequently move the main spring abutments to shorten the length of the main suspension springs as the speed of the car increases.

Reverting to the A frames, in the present car all the connections are made with ball joints, as it was thought that it might be desirable to allow a slight fore-and-aft flexibility; but it has been found that there is no reason why plain pin joints, which would, of course, greatly simplify construction, should not be used.

In order to transmit the drive to the road wheels one link of each pair of A frames is made hollow and



BIRDSEYE VIEW AND UNITS OF HOLLE CHASSIS



FRONT VIEW OF CHASSIS

contains a driving shaft. There are, of course, universal joints in the shaft at both ends, and a bevel wheel, with helical teeth, on the extension of the shaft beyond the joint, gears with another toothed wheel on the hub. The general arrangement of a driving wheel unit is shown below.

Each of the road wheels is mounted on an inclined pivot, so that it can be steered on the Ackermann principle. The pivots are, in the actual chassis now under test, inclined at an unusually steep angle in order to lie in line with the point of road contact; but we were told that no trouble is experienced from this cause, and that there is a vertical rise and fall of only $^1/_{32}$in. in passing from full lock in one direction to full lock the other way.

Since the back wheels have to be turned in the opposite direction to the front wheels to follow round the curve, a centrally pivoted lever is arranged in the connecting links to effect the necessary reversal. The main steering gear is connected directly with the front wheels and a connection is taken back from them to the rear wheels. It is in this connection that the lever just mentioned is arranged. A rather ingenious device has been incorporated in the construction of this lever, to enable the system of steering to be changed at will. The lever is not only pivoted at its centre, but can also be doubled back on itself about a hinge at the pivot. If the lever is doubled up the connections at its two ends come alongside one another, and then the front and back wheels are, of course, steered in the same direction. With the gear set in this manner the car can be steered "crabways," as shown in one of the half-tone engravings on page 670. With the lever set midway between the two extremes the back wheels are locked, but the front wheels can be used for steering as in a normal car.

The only other feature of the car of special interest from the constructional point of view is the "distribution box,"—illustrated above—which is used to distribute the driving power to the several wheels. In ordinary running—that is to say, with four-wheel steering—the two wheels on either side of the car follow round the same curve and consequently can be connected together, but the wheels on opposite sides of the car must obviously have a differential action. The distribution box consequently has a differential gear, on the opposite ends of which there are two bevel wheels that mesh with pinions on the driving shafts of the road wheels. Two brake drums, which may be water cooled, are also arranged in connection with the distribution box.

An ordinary change-speed gear-box is used to connect the distribution box with the clutch and engine, but it is obvious that the whole of the gearing might be enclosed by one casing. The engine and general control gear are of the normal four-cylinder 11.9 horse-power Anzani type, similar to that used on the "A.C." cars we recently described.

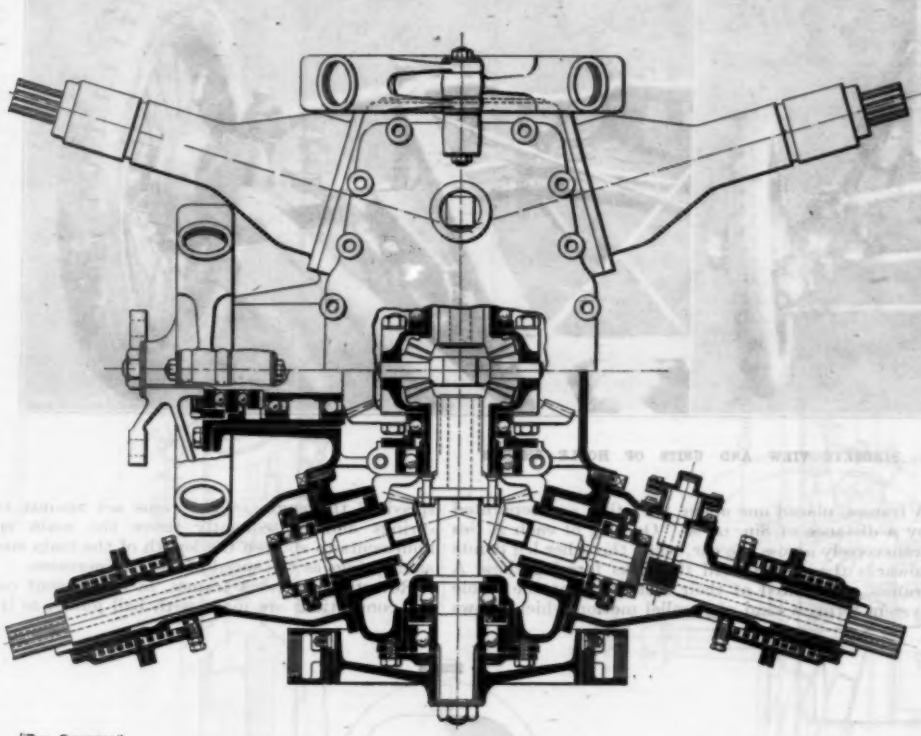
The trials of the new car which we witnessed last week took place on Box Hill, in Surrey, on a day when it was drizzling fine rain. The conditions were therefore ideal for testing the capabilities of the vehicle, which was driven by Mr. French, of French's Engineering Works, Balham, which made the chassis. The trials were witnessed by a party which included Colonel Wilfred Ashley, Under-Secretary of State for War, and several officials from Aldershot.

About halfway up the rise to the summit of Box Hill a piece of heath land was picked out where a narrow valley with sides rising at an angle of about 1 in 3 led down to a rough gully. The car was driven back and forth across this gully and up the slopes on either side at a speed which we estimated was at least 20 miles per hour. There were three passengers on board during several of the runs, and although, as will be gathered from the photographs reproduced on page 670, there was little hand hold on the chassis, they had no difficulty in keeping their seats during this rough riding.

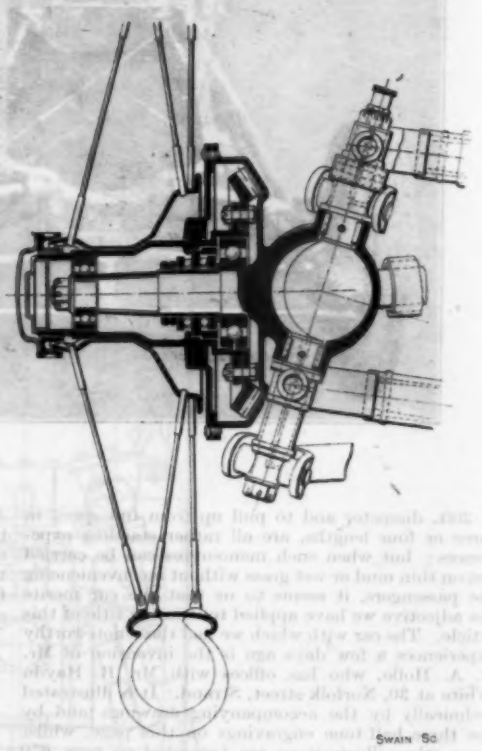
On the opposite side of the road there was another piece of broken ground, of which one of our views, showing the off-side front wheel in a hollow, is typical. The car would take ground like this at full speed without discomfort to the riders, and would also pull out of the most boggy holes with certainty—a fact which must be largely accounted for by the interconnection between the front and back wheels on either side.

After these rough-riding trials the car was taken down on to the main road, which has a tarred surface and had a thin covering of greasy mud. Several attempts were made to force it to skid, but it would not, although another car passing by had a serious side slip at the same spot in the intervals of the trials.

The whole machine is a workmanlike engineering job, and although the present chassis is an experimental example, which can obviously be simplified in some details, it appears to us that there are good prospects for a car of this type in rough country. The inventor is already working on the design of a vehicle embodying the same general principles, which will have ten wheels, and is intended for heavy cross-country transport in roadless countries.



DISTRIBUTION BOX



DRIVING WHEEL UNIT

CENTRIFUGAL TREATMENT OF PETROLEUM.

Two papers on the use of the centrifugal process in the refining of petroleum oils were presented at a meeting of the Technological Section of the American Institute of Petroleum. A paper by E. E. Ayres on "Centrifuging Petroleum Refinery Emulsions," stated that in the resolution of emulsions, centrifugal force is better than gravity for subsidence, in which the suspended oil globules are brought into contact, but for coalescence by rupturing the films around the globules, centrifugal force is only slightly better than gravity. With water-oil emulsions, however, partial coalescence may often be obtained by centrifugal force, and rotors are specially designed to meet this condition. The removal of wax from petroleum lubricating oils by the centrifugal process was dealt with by Leo D. Jones, who explained that this development resulted from efforts to secure better results than those attained by the common cold-settling process. For many years the only centrifugals available were of the cream-separator class, which could not handle successfully a liquid and a plastic solid. Soon after centrifugals operating on the principle of hydrostatic balance were put in use, it was discovered by Mr. P. T. Sharples that the wax separated by centrifugal force differed from the slushy liquid separated by gravity, and would not act freely as a liquid in the centrifugal. This trouble was overcome by the use of a stratum of a third liquid, heavier than either of the separated substances, giving a frictionless surface on which wax might float and flow, and providing a uniform non-resistant liquid in hydrostatic balance with the wax-free oil layer.

SIXTY YEARS AGO.

In the 'sixties there were still some in high places who held simple beliefs or doubted simple facts connected with the operation of steam engines and other engineering products. From a note in our issue of December 18th, 1863, we learn that Mr. Isherwood, the Engineer-in-Chief of the United States Navy, was doubtful whether steam worked expansively gave out more power in proportion to the weight of steam used than when it was worked without expansion. He had conducted experiments at great length on the subject. He found, we believe, that in certain circumstances there was no advantage in expansive working, and in some cases actually a loss. The precise conditions under which such lack of advantage or positive loss was found were the use of low-pressure saturated steam, of unjacketed cylinders, and of slow piston speed. The futility of his investigations was apparently the subject of comment and inquiry, for we find it stated that, when under cross-examination, he candidly admitted that before he received his commission as steam engineer in the United States Navy he had never had charge of an engine. . . . In a leading article in the same issue we expressed our pride in the growth of the Institution of Civil Engineers, which we characterised as "the real exponent of our professional power." We claimed that, in spite of the remarks made by *The Times* on the occasion of "glorious Robert Stephenson's" death, engineering had attained to the dignity of being the fourth profession. But praise was given for the fact that, unlike the barrister, the medical man and the vicar, the engineer was neither tongue-tied nor conscience-bound, and that he was free to indulge the independent exercise of thought, to overturn, if he desired, one day what had been carefully built up the day before. The wealth of the kingdom had, we wrote, within the last few generations been more than octupled by the labours of British engineers, a statement which surely could not be made of "the gentlemen of the church, the bar or of the medical fraternity." . . . In a review of a book, entitled "Description of Richards' Improved Steam Engine Indicator," by Charles T. Porter, we quoted, apparently in full, an appendix, in which the author dealt with the application of the device to locomotives. From this account we learn that the author, Mr. Zerah Colburn and Mr. Maw had, through the courtesy of Mr. Sinclair, engineer of the Great Eastern Railway, recently journeyed from London to Yarmouth and back on the buffer beam of an express engine, and during the trip had taken diagrams by means of a Richards indicator from the cylinders. Mr. Maw, "from Mr. Sinclair's office," was entrusted with the duty of logging the engine speed, the gradients and the times at which the diagrams were taken. It is perhaps unnecessary to state that Mr. Colburn was at that period editor of this journal, and that Mr. Maw was, in a short time, to assume the editorship of *Engineering*, a post which he still retains.

SAFETY FIRST.—We have received from the Chief Inspector of Factories (Home Office) a copy of Safety Pamphlet No. 8, which is now on sale at Government publishers at 1s. net. It is entirely devoted to the protective devices used in connection with woodworking machinery, and as it is very copiously illustrated, it should appeal at once to the managers and owners of woodworking shops. We note that saws, circular, band and frame, occupy the larger portion of the pamphlet. The number of safety appliances that have been invented to secure absolute safety in the manipulation of circular saws is bewildering, yet the Inspector remarks that "there is no single fitment which is universally applicable to every aspect of such a variable tool. There is, however, no sawing operation for which it is not possible to provide reasonable safeguards or safe methods of working." There is much virtue in that "reasonable."

Railway Matters.

In addition to the widening of the Cambrian section between Welshpool and Forden, as announced in this column on April 13th last, the Great Western is about to convert from single to double line the 3 m. 74 c. between Dovey Junction and Machynlleth on the same section.

We hear with regret of the death of Mr. Lionel R. Wood, who was the engineer of the Pembroke and Tenby Railway when that line was acquired by the Great Western. Mr. Wood was subsequently a divisional engineer on the latter, and eventually became the permanent way engineer in succession to the late Mr. T. Lough, and retired some four years or so ago.

According to *Reuter*, Lord Reading, replying to an address of welcome at Madras on the 10th inst., foreshadowed further railway development, and announced that sanction had been given for the construction of three important lines on which work would be begun shortly. The rates of interest on Government loans were high, and all railway projects must be remunerative.

Anyone interested in railways who has not been in Scotland of late will almost rub his eyes to see many coaches painted with "Midland" red in what may be called Caledonian stations. The long familiar white paint of the "Caledonian" coaching stock had become so much a part of the Scottish railway system that its disappearance will be very noticeable and much regretted.

We are informed that the National Wages Board met in private one day last week to consider its findings on the claim of the railway companies for a modification of the National Agreement. It was said that the award was expected to be issued this week, but at the time of writing it has not appeared. There is reason to believe that, on the whole, it will favour the contention of the men.

The London and North-Eastern Railway Company has had its coat of arms authorised by the Herald's College. It embodies the main features of the crests of the six companies out of which it is composed. In the arms is incorporated the Great Central's motto "Forward," and, to quote the technical description, "And for the Crest On a Wreath of the Colours Issuant from Clouds of Steam the Figure of Mercury Proper."

Mr. A. W. Szlumper, C.B.E., chief engineer of the Southern Railway, presided on Wednesday at the distribution of certificates to the Crystal Palace School of Practical Engineering, and addressed the students. He spoke of the grouping of the railways as destined to bring about efficiency and economic working. Everything would be standardised among the railway groups, and by this means there would be a considerable reduction of maintenance cost.

Four railway directors—Sir Evelyn Cecil (Aston), Sir Robert Horne (Hillhead), Mr. M. J. Wilson (Richmond), and Colonel David Davies (Montgomery)—have secured re-election to Parliament, whilst two—Sir Edwin Stockton (Manchester Exchange) and Lieut.-Colonel A. C. Murray (Kincardine and Western) lost their seats. Sir Philip Dawson (Lewisham West) was re-elected. The Labour Party not only retains Mr. J. H. Thomas (Derby), Mr. H. C. Charleton (Leeds South), and Mr. T. Louth (Ardwick) as railway members, but has three others—Messrs. H. G. Romeril (St. Pancras South-East), A. Law (Bolton), and T. E. Groves (Stratford).

The London and North-Eastern Railway Company is building at its several manufacturing depôts:—Twenty "Pacific" type locomotives and 12 passenger tank engines at Doncaster; 10 0–8–0 three-cylinder mineral engines of the North-Eastern type; and 50 2–6–0 three-cylinder goods engines of the Great Northern type at Darlington. Distributed between the wagon shops at Faverdale, Doncaster and Dukinfield are 5700 open 12-ton wagons, 3000 12-ton end-door mineral wagons, 500 20-ton mineral, 1350 15-ton mineral, 500 12-ton covered goods, 300 10-ton perishable wagons, 500 double-bolster wagons, 250 10-ton covered fish, 550 cattle wagons, and 100 20-ton goods brakes.

The Great Western Railway Company has hitherto done less than some of its neighbours in the matter of shunting by gravity. One of the three yards at Bristol has, however, now been provided with a "hump," so that gravitational shunting may be used. There are three yards at Bristol—one at the London end, one at the Taunton end, and one on the South Wales side. The east depôt—the London end—has sidings on the up side and on the down side. It is for the sidings on the up side that the hump has been provided. Trains are received from the West, South Wales and the other yards in Bristol on one of three reception lines, and taken thence into the shunting neck, whence an engine propels them back and up the hump of 1 in 50. On the summit the wagons are uncoupled as required and run down the 1 in 50, falling, on the other side of the hump, and are sorted, without further assistance, into fourteen sidings.

Next to the Quintinshill disaster of May 22nd, 1915, the most horrible railway accident of recent years was that of which last Tuesday was the eighth anniversary. We refer to the collision at St. Bede's Junction, Jarrow, where a light engine which, unknown to the signalman, had "banked" a goods train from Tyne Dock, stood on the main line. The signalman admitted a passenger train into the section, and after the consequent collision fire broke out in the wrecked carriages and seventeen passengers were either killed by the collision or were burnt to death. A year and a day after this disaster there was an unusual coincidence in the matter of railway accidents. The "Postal Train" that left Euston at 8.30 p.m. came to grief just after leaving Kirtlebridge, and the Windermere mail that left at 10 p.m. was in collision at Wigan. One servant was killed in the former—the "Postal" caught up and ran into a goods train—and a servant and a member of the travelling post office were killed in the latter. Snow had been falling heavily all day at Kirtlebridge, but the signals were in good order, and no explanation was forthcoming, for the men on the two engines of the express passing them. The outstanding feature of that case was that three detonators were exploded and yet the enginemen did not hear them.

Notes and Memoranda.

The coal output at the mines of Great Britain for the week ended December 1st was 5,719,200 tons, against 5,726,300 tons for the preceding week and 5,573,300 tons for the corresponding week last year.

The problem of erecting steam power plants is being discussed by the Ontario Hydro-Electric Commission. A steam plant of 100,000 horse-power, with an ultimate capacity of 300,000 horse-power, is proposed for Toronto.

It is claimed in America that the Wilson dam across the Tennessee River will be the largest monolith in the world. The dam will be 5000ft. long by 101ft. wide and 125ft high. It will contain 1,260,000 cubic yards of concrete, and will probably cost about 50,000,000 dollars.

With an average price stated to be less than 1¼d. per unit, the Poplar Electricity Committee reports having sold, during the September quarter, 5,870,955 units, an increase over the corresponding quarter of last year of 649,947 units. The net income showed an increase during the same period of £5395, and working expenditure an increase of £3958.

The largest reciprocating engine so far manufactured in Australia has recently been set to work at the Hoskins Ironworks, Lithgow, New South Wales. It is a blowing engine, made by Thompson and Co., of Castlemaine, and has an output of 60,000 cubic feet of air per minute. The total weight of the machine is 330 tons, and some of the castings weigh as much as 33 tons.

A detailed investigation of the iron *ore* resources in Lapland has proved that the amount is far greater than had been indicated by a previous examination. It is now estimated that 1,500,000,000 tons of iron ore of high quality are available. Over 2000 samples have been tested for iron, sulphur, and phosphorus contents. As a result of this investigation, it is anticipated that large quantities of non-phosphorus ore will be released for export purposes.

There has been constructed in New Jersey an experimental moving platform, in the form of a loop 200ft. long and 100ft. wide. It comprises an inner fixed platform, two slow loops running at 3 and 6 miles per hour respectively, and an outer loop, with seats, going at 9 miles per hour. The inner platforms are driven by rack and pinion, while the fast one has what may be described as a flattened out induction motor. The weight of the rolling stock is 350 lb. per passenger. The power consumption is said to be 150 horse-power per mile and the capacity 35,640 passengers per hour.

In his address to the annual meeting of the shareholders in the Rhodesian Congo Border Concession, Limited, which was held on Wednesday last, the chairman announced that important discoveries of ore had been made in the territory within the company's concession. Although, he said, it had been possible in the short time which had elapsed since the commencement of their operations to prospect only a very small portion of the whole concession, important discoveries had already been made, particularly in two areas, namely, in the north-east corner at N'Changa and the south-east corner, where several copper-bearing deposits had been reported, and, in addition, the presence of gold in the Lunsemfwa River had been discovered.

Observations made in experimental work on sponge iron and synthetic cast iron, performed at the Seattle station of the American Bureau of Mines, led to certain conclusions regarding reduction and carburisation that differ in some respects from prevalent belief. These findings are being further studied. As a result of this work it would seem that it may be possible to produce low carbon iron from the blast-furnace. In order to obtain exact data on the combination of carbon with iron, reduction tests are being carried on with molten iron in contact with solid carbon and with gases. In the course of this work, it was found that gases—methane, acetylene, or carbon monoxide—were valueless for introducing carbon into molten iron, but the solid carbon dissolved rapidly.

Discussing the merits of centrifugal machines for drying coal, before the Northern Section of the Coke Oven Managers' Association, Mr. T. Nicholson, the President, said that centrifugals were essentially high-speed machines, and as such required careful handling in every direction, particularly so as regards even loading. An objection of greater importance to their use for coal-drying lay in the fact that a separation and concentration of what they called "slurry" could not be avoided. Further, the method had its limitations in the proportion to which coal could be dried in relation to its initial moisture, which in turn was dependent upon the size of coal. In other words, a mixture of coals containing 12 per cent. water could be dried to, say, 7½ per cent., but a mixture with 18 per cent. could only be reduced to 10 per cent. To take an extreme case, he was informed that it had been found by experiment that fines passing through ⅛in. mesh by themselves were incapable of treatment by the centrifugal method.

In the course of an article contributed to the *Journal* of the American Society of Mechanical Engineers, Mr. W. L. Churchill urges the desirability of employing mechanical engineers in woodworking factories. The mechanical engineer in the management of woodworking industries is, he says, almost unknown. So rarely is he found in this connection that he usually occasions surprise and wonder as to how he happened to be there and why the responsible power selected him instead of a "practical woodworker." And yet there is no major industry that is more in need of the mechanical engineer in its management function than the broad class of enterprises coming under the head of woodworking. This fact, when recognised by the mechanical engineering schools and profession, will open up a large field of usefulness for the mechanical engineer heretofore comparatively neglected. It will also tend to correct many of the inefficiencies now existing in woodworking operations, and place the industry as a whole upon a more profitable basis. Not only does this field open up a large number of opportunities for the properly qualified engineer, but his introduction into the industry will lift its present low average of earnings to a much more satisfactory level.

Miscellanea.

It is announced that the production of radium from the works of Oelem, Campine, amounts this year to 12½ grammes.

It has been decided to install a 10,000 kilowatt set in the Pretoria power-house, at a cost of £40,000. The new set, it is expected, will meet all requirements until the end of the 1925 winter.

A syndicate is erecting a sugar beet factory at Southwold Harbour in time for next season, and has also acquired the harbour, while a circular railway of about 45 miles in length and embracing about 200,000 acres is in contemplation.

The British Empire Steel Corporation proposes to put into operation the battery of coke ovens erected in 1921 at its Sydney, Nova Scotia, plant by the Koppers Corporation. These ovens, which were said to have cost several millions, had been idle since their erection.

It is reported that the Colombian Government has granted a concession to the Andean National Corporation, of New York City, for the construction of a pipe line extending 800 kilom. from the coast near the mouth of the Magdalena River to the oil lands in the interior.

The tail portion of a monoplane was recovered from the sea at Seabrook, near Hythe, on Wednesday last. There is no identification mark on the wreckage, and the authorities are unable to form an opinion as to whether it is part of the machine piloted by Mr. Sperry, the American airman, who was seen to fall into the sea off Hastings recently.

It is reported from Prague that the Telegrafia Company of that city, in which the Czecho-Slovak Ministry of Posts and Telegraphs holds the controlling interest, has signed a contract with the Relay Automatic Telephone Company, Limited, of London, for the manufacture of patents under a licence for ten years. This is the first time a British electric business has succeeded in competition with the long-standing German monopoly in Central Europe.

The objects of the recently formed National Association of Water Users are:—"To scrutinise, and, if found desirable, to oppose all attempts on the part of water authorities or associations to impose any standard specification of water pipes and/or fittings to the exclusion of all other pipes and fittings which are sound, suitable and efficient." Mr. F. W. Davy, 11, Henrietta-street, Cavendish-square, London, W. 1, has been appointed secretary.

According to the *S.A. Mining and Engineering Journal* there is news of a discovery, claimed to be of great importance to Uganda, and perhaps to Kenya, that petroleum has been found near Kibero, on the Lake Albert Flats, by the Government geologists. Three barrels of this petroleum have been sent to England for analysis. Meanwhile the Government is sending out boring outfits, and the Assistant Geologist is camped at the well. From the configuration of the country it would appear that this deposit may be a continuation of the Inyaminga petroleum measures.

At a Court of Common Council, at Guildhall, on Thursday, the 13th inst., a motion was submitted by Colonel Vickers Dunfee, Deputy, "That, having regard to the great inconvenience to traffic caused by the continued opening of boxes in the streets of the City by the Post Office authorities, the Streets Committee be instructed to submit a return of the number of manholes in the main streets, the number of times each one has been opened during the past year, and whether the works have been carried out by day or by night, and to report as to any steps that can be taken to minimise these serious obstructions to traffic." The motion having been carried was referred to the Streets Committee accordingly.

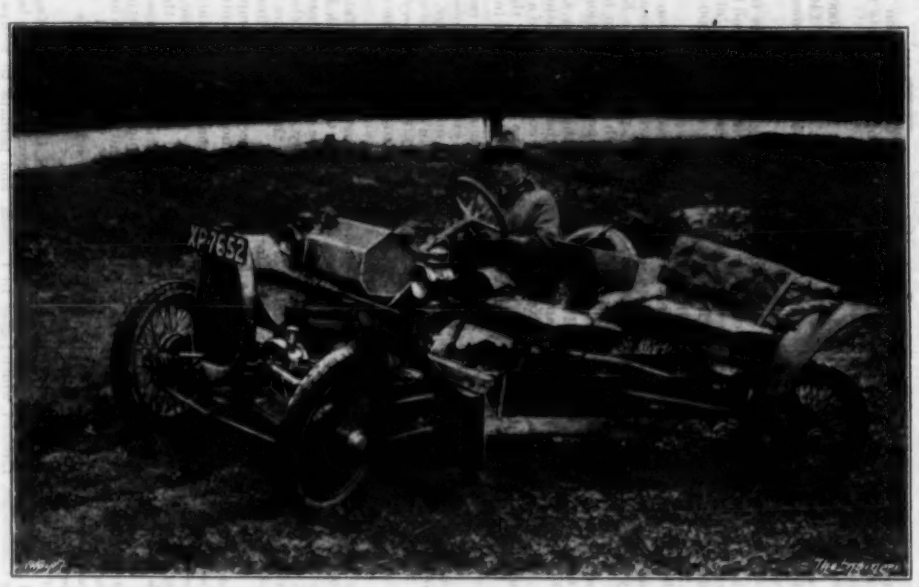
On Wednesday, December 12th, at the Southend-on-Sea Rotary Club, Mr. W. J. Liberty, of the engineer's department of the Corporation of London, gave an illustrated lecture on "Underground London," dealing with mains and main-laying in Central London, obstructions, &c. He also dealt with the recent accident in South London in connection with the enlargement of the City and South London Tube Railway, illustrating his remarks with lantern slides showing the apparent cause and results following the explosion of the South Metropolitan Gas Company's main, and spoke of the safety of such tubular railways when once constructed. By the aid of some ninety specially prepared slides, he was able to give the members an idea of modern underground London.

On Wednesday last the King of the Belgians laid the foundation of the new inter-Continental wireless transmitting station at Ruysseleda, in West Flanders. The station is to be provided with three 250-kilowatt aerials, which can either be used alone or in parallel pairs. It will be possible to transmit messages on wave lengths of from 16,000 m. to 25,000 m., and to operate at a speed of 100 words per minute. It is expected that the station will be sufficiently powerful to communicate with all the big stations in the world. It is, however, principally intended to be a relay station, messages for transmission being forwarded to it by telegraph. In his speech King Albert stated that the station would link up the Belgian Congo with the Mother Country, and would render Belgium independent so far as wireless messages was concerned.

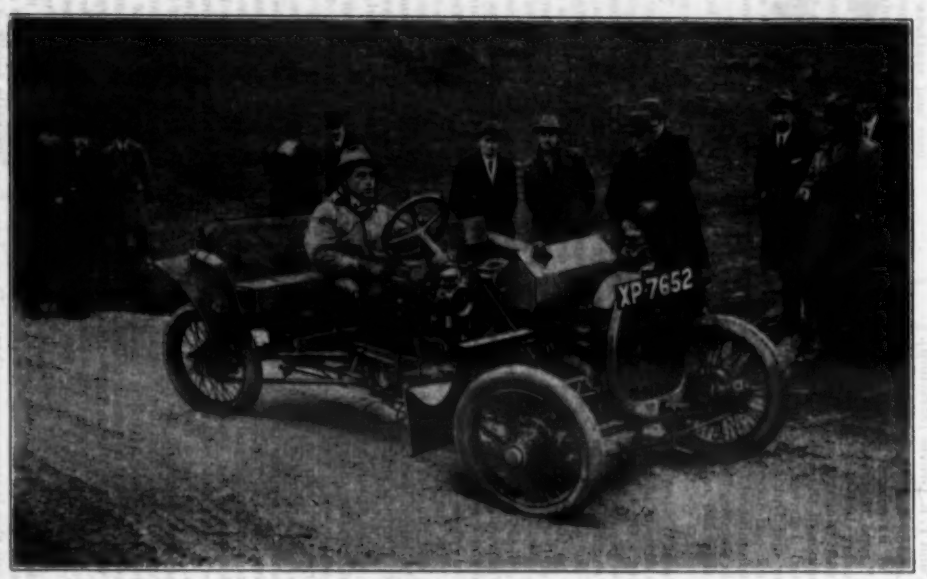
The Commercial Secretary at Constantinople reports that he has now arranged a representative selection of catalogues of British firms in his offices at the British Consular residence at Galata, Constantinople. In order, however, that British catalogues may be available for traders in the interior, arrangements have been made, by courtesy of the Imperial Ottoman Bank, for British catalogues to be displayed at their agencies in the following towns in the interior:—Broussa, Adrianople, Konia, Smyrna, Trebizond, Eskishehir, Adana, Angora, Mersina and Samsoon. British firms desiring their catalogues to be displayed at any or all of these towns, are invited to send sufficient copies to the Imperial Ottoman Bank, Limited, Trade Development Department, 26, Throgmorton-street, E.C. 2, which will arrange for their re-transmission to Turkey, subsequently submitting a claim for the cost of postage.

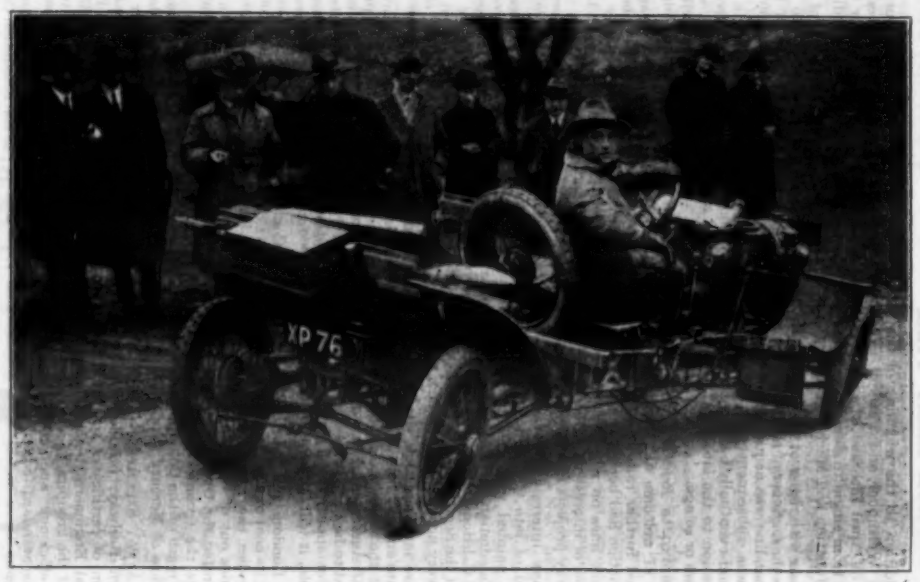
THE HOLLE FOUR-WHEEL-DRIVING-AND-STEERING MOTOR CAR

(*For description see page 667*)



DRIVING OVER ROUGH GROUND

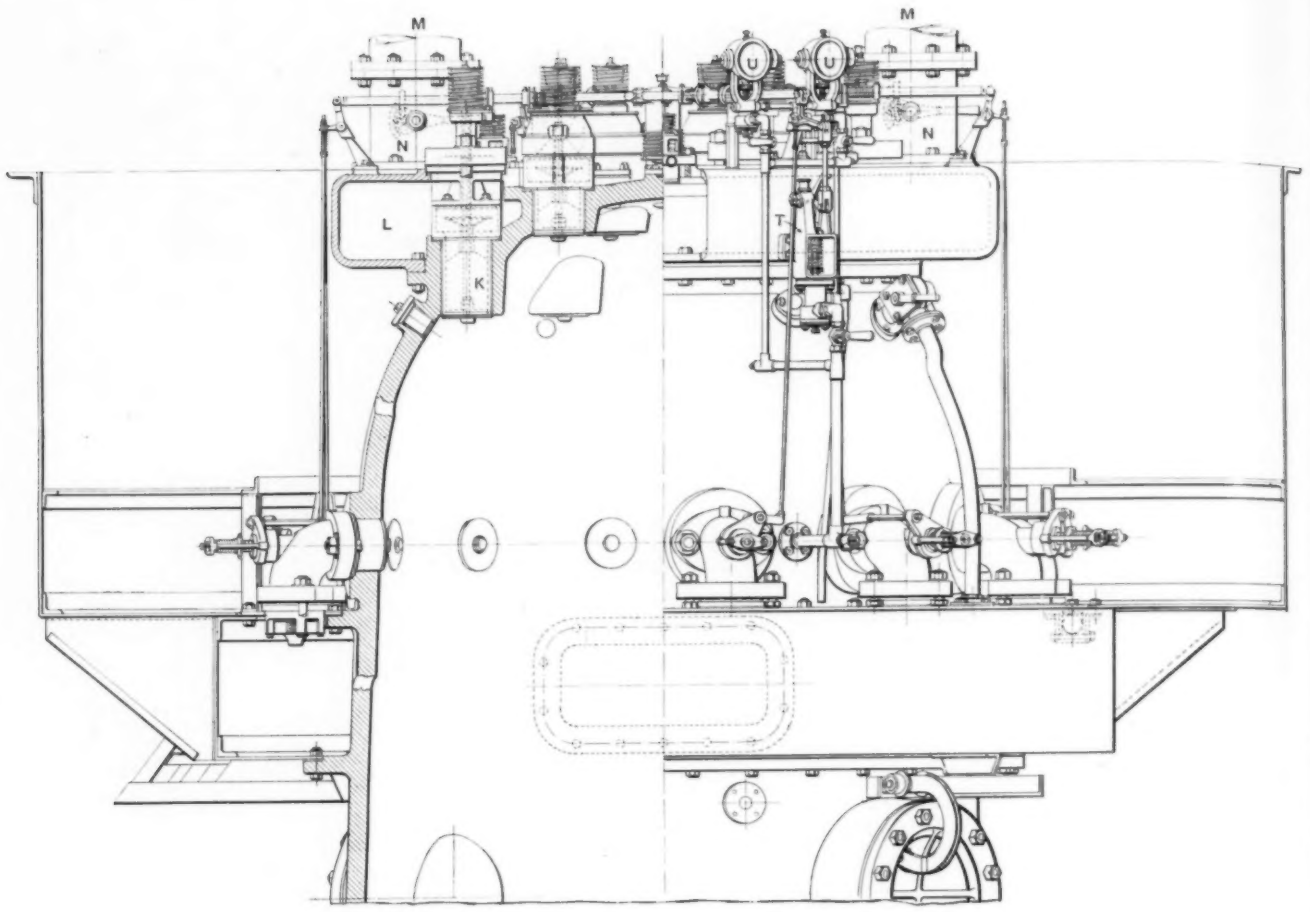




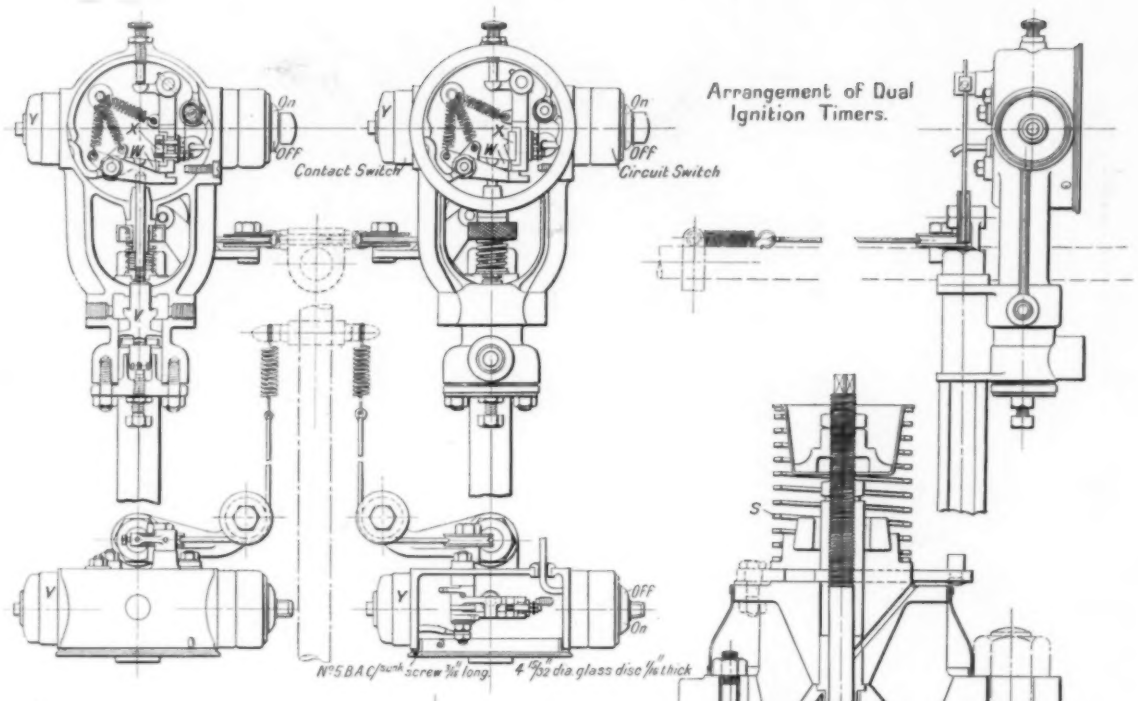
"CRAB" STEERING

HUMPHREY PUMP FOR THE SO TH

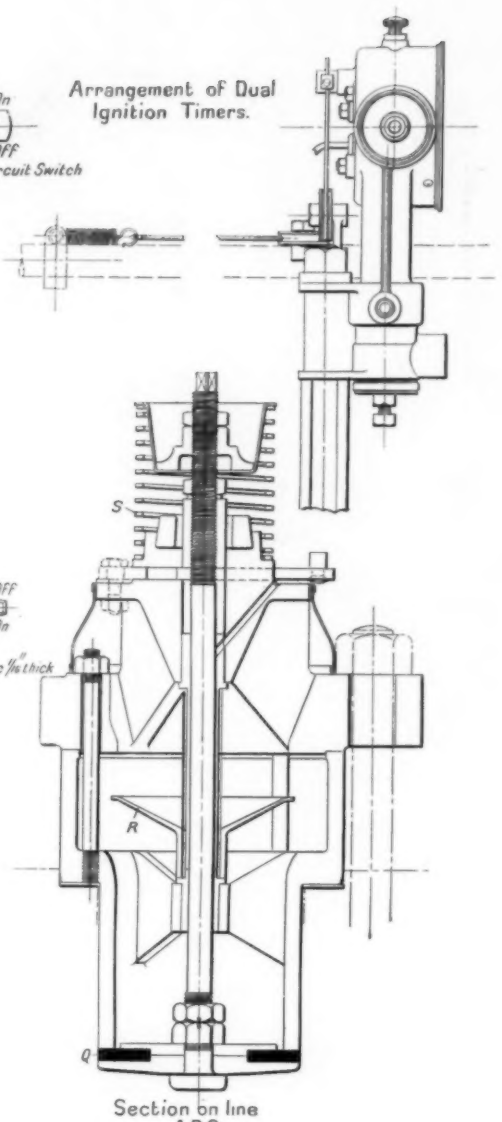
WILLIAM BEARDMORE AND CO., LTD., GLAS



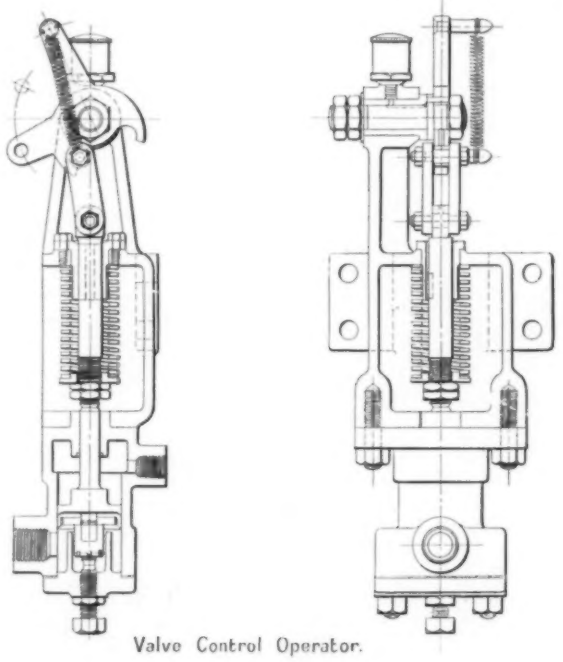
GLASGOW AND LONDON, ENGINEERS.



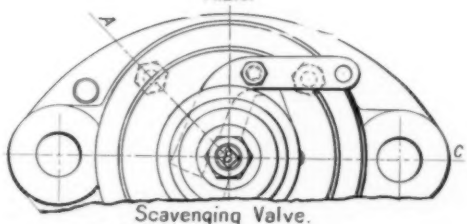
Arrangement of Dual Ignition Timers.



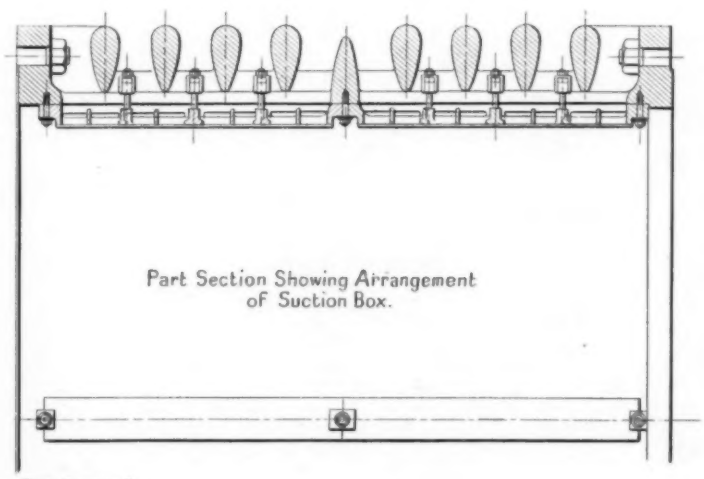
Section on line A.B.C.



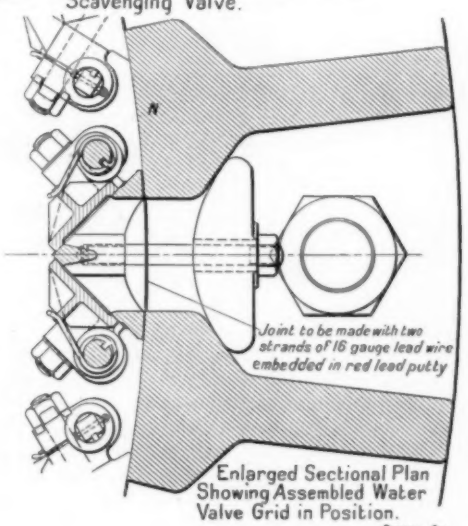
Valve Control Operator.



Scavenging Valve.



Part Section Showing Arrangement of Suction Box.



Enlarged Sectional Plan Showing Assembled Water Valve Grid in Position.

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Contents.

THE ENGINEER, December 21st, 1923. PAGE

A SEVEN-DAY JOURNAL .. 659
EXPERIMENTAL RESEARCHES ON PROPELLER CAVITATION. No. IV. (Illus.) .. 660
LINKS IN THE HISTORY OF THE LOCOMOTIVE. No. II. (Illus.) .. 661
INSTITUTION OF MECHANICAL ENGINEERS. (Illus.) .. 663
INSTITUTION OF ELECTRICAL ENGINEERS .. 665
A REMARKABLE MOTOR CAR. (Illus.) .. 667
CENTRIFUGAL TREATMENT OF PETROLEUM .. 668
SIXTY YEARS AGO .. 668
RAILWAY MATTERS .. 669
NOTES AND MEMORANDA .. 669
MISCELLANEA .. 669
LEADING ARTICLES—
Internal Combustion Engine Phenomena .. 671
Engineers of the Future .. 672
LITERATURE .. 672
LARGE HUMPHREY PUMPS FOR AUSTRALIA. (Illus.) .. 673
EXHAUST VALVE AND CYLINDER HEAD TEMPERATURES IN HIGH-SPEED PETROL ENGINES. (Illus.) .. 675
LETTERS TO THE EDITOR—
Clyde Marine Oil Engines .. 676
The Gas Turbine .. 676
LAUNCHES AND TRIAL TRIPS .. 677
PROVINCIAL LETTERS—
The Midlands and Staffordshire .. 677
Lancashire .. 677
Sheffield .. 678
North of England .. 678
Scotland .. 679
Wales and Adjoining Counties .. 679
CONTRACTS .. 679
CURRENT PRICES FOR METALS AND FUELS .. 680
FRENCH ENGINEERING NOTES .. 681
BRITISH PATENT SPECIFICATIONS. (Illus.) .. 681
FORTHCOMING ENGAGEMENTS .. 682
PERSONAL AND BUSINESS ANNOUNCEMENTS .. 682
PARAGRAPHS—
Safety First .. 668
Royal Institution .. 677
Institution of Mechanical Engineers .. 677
Ship Repairing at Southampton .. 679
Breaking-up Scrap Metal .. 682
The Society of Engineers .. 682

TWO-PAGE SUPPLEMENT—HUMPHREY PUMP FOR THE SOUTH AUSTRALIAN GOVERNMENT.

THE ENGINEER.

DECEMBER 21, 1923.

Internal Combustion Engine Phenomena.

IN the paper presented by Professor Gibson and Mr. Baker before the Institution of Mechanical Engineers last Friday, the ground covered is so extensive and the experimental data are so crowded one upon another that it is difficult to draw any general conclusions from the facts revealed, striking and interesting though many of them are. Possibly it would be wisest to set our faces somewhat rigidly against deducing from the paper any general conclusions, for in studying it we are made aware almost at every turn that the results arrived at cannot be claimed to have other than individual significance. They relate only to certain specific types of petrol engines—or, to be more precise, to one design of a well-known motor car engine and to four designs of air-cooled aero-engines. In all instances the test figures were derived, not from a complete engine, but from a single cylinder unit of it. The specialised nature of the designs tested, together with the exceptional conditions of the tests, should be sufficient to caution us to tread warily in the matter of drawing general conclusions from the results, and if these considerations are not found sufficient, the clash of opinion and fact revealed in the course of the discussion ought to convince us that for the time being the results arrived at by Professor Gibson and Mr. Baker should not be extended beyond the engines and conditions to which they are immediately applicable. At the same time, there cannot be the slightest doubt that the paper provides much matter for thought, and opens up a wide field for further experimental investigation regarding the behaviour of the most impressionable form of prime mover which engineers have given to the world.

In comparison with the steam engine, the internal combustion engine is very sensitive to alterations, even slight alterations, in its design and the conditions under which it is put to work. Hence proportionally difficult and complex is the scientific examination of its behaviour and the variations thereof produced by modifications in its construction and working. In its narrowest sense, Professor Gibson and Mr. Baker's paper was devoted to an examination of the temperatures reached in the exhaust valves and cylinder heads of petrol engines, but before a satisfactory discussion of this subject could be presented, the authors found it necessary to investigate the effect of twelve principal variables, and ended up by presenting a respectably complete conspectus of the action of high-speed petrol engines at several important points. Many of the results deduced are sufficiently novel not yet to have reached the stage of being accepted by all or most designers. Nearly everywhere we find ourselves on debatable ground. Take, for example, the ostensible object of the research, the temperatures reached by the exhaust valves and the cylinder heads. It is by no means certain that the authors have succeeded in devising a satisfactory method of measuring the temperatures. Only with great difficulty was it found possible to design a form of thermo-couple which, when applied to the exhaust valve, would withstand the relatively rough mechanical movement to which that part is subjected in a high-speed engine. When at last they succeeded in this object, it was found that it would be out of the question to apply the thermo-couple to the exhaust valves of all the engines which it was desired to test. Accordingly, the valve fitted with the thermo-couple was used simply as a means of calibrating an optical form of pyrometer sighted on to the shoulder of the exhaust valve. The comparison of the preliminary test figures yielded by the thermo-couple and the pyrometer when applied simultaneously to an engine gave good agreement, but it cannot be other than regretted that it was not found possible to employ thermo-couples throughout. The pyrometer method involves running the engine with an open exhaust in order that a line of sight on to the valve stem may be obtained, and while such a proceeding may or may not affect the temperature of the valve, there is reason to suspect that it may affect other factors measured by the authors. Even, however, if it be assumed that the method of measurement by means of a pyrometer does not introduce a serious error, it has to be considered that the temperature of the exhaust valve in common with that of other internal parts of the engine is not demonstrably constant, and that, as Professor Coker contends, it probably fluctuates through a cycle in unison with the cyclic variation of temperature of the working substance. Some contend that in a high-speed engine running at not far short of 2000 revolutions per minute, there can be no time for a cyclic change, and that the temperatures recorded are the true temperatures of the parts to which they relate. Nevertheless, the doubt must remain, until it is definitely removed, that the figures given in the paper may be mean values only, while the maximum values actually reached may be considerably greater. Take, again, the question of the sparking plug and its position. It was found that while the position of the plug affected the exhaust valve temperature to a relatively small extent, it had a material influence on the consumption of fuel per brake horse-power hour, both in one of the air-cooled aero-engines and in the water-cooled motor car engine. In the first-named engine a mere shift of the diametral line containing the two plugs through 90 deg. resulted in the same horse-power being developed for 5 per cent. or so less petrol. In the second-named engine it was possible to use either a horizontal plug or one inclined at 35 deg. to the horizontal. In all trials the horizontal plug gave noteworthily better results, both by increasing the output and decreasing the consumption. As the spark was advanced the advantage shown by the horizontal position decreased, but as the engine was throttled down, the advantage increased. These interesting and apparently significant results cannot, however, be accepted as of general applicability. Professor Baker pointed out that in the case of the motor car engine there was an additional unsymmetrical factor at work other than the inclination of the plugs, namely, the curvature of the inlet passage in the cylinder head. So far as this engine is concerned, therefore, there is no assurance from the experiments that the effects noticed were not due to a peculiarity of the design, quite apart from the sparking plug arrangement. In the aero-engine example, some similar cause was no doubt at work, although the information given in the paper is not sufficiently detailed to enable us to form any definite conclusion on this point. Of the many other interesting points covered in the paper, we can here deal with but one, the form given to the exhaust valve head, the width of the valve seat and the valve lift. These factors have attracted very close attention, particularly from aero-engine designers, but it cannot be said that the paper adds materially to our knowledge concerning their influence. As Colonel Fell showed, the designs of valve head experimented with by Professor Gibson and Mr. Baker are now regarded with disfavour, and one of a radically different form is receiving attention. In the matter of the width of the valve seat, the experimental results indicate that by doubling the width the

temperature of the valve is actually increased. This finding is quite contrary to what would be expected, and must, we think, be set down as a direct consequence of the geometry of the particular engine to which it relates. As regards the effect of valve lift, the experiments were, as Mr. Low implied, not carried far enough. The greatest lift employed was less than the theoretical maximum opening lift, and as a consequence no information is afforded which would enable us to examine the truth or otherwise of the result recently registered in America that the flow through a poppet valve is still short of the maximum when the lift is equal to one-quarter of the valve port diameter.

Of those who took part in Friday's discussion, Professor W. E. Dalby alone made any serious attempt to treat the subject of the paper on general lines. He urged that the subject indicated in the title of the paper should be regarded as but one section of a general study in heat transmission as applied to the working parts of internal combustion engines. Extending his view, we may say that the complete problem embraces not only an investigation of the temperature of the exhaust valves and cylinder head, but of the heat flow through the cylinder walls, the piston, the inlet valves and other parts, all observations being made in strict conjunction with observations of the engine output. It may be doubted whether much practical good is to be gained by studying the different aspects of the general problem separately at different times and by means of different engines. Yet the complexity of the subject in view is so great that few people can be expected to have the time and opportunity to attack it as a whole. When we recollect that even in relatively simple cases the theory of heat transmission is still at many points vague and unsatisfactory, it seems almost hopeless to anticipate that the many interacting aspects of it afforded by the internal combustion engine should ever be brought within our ready and simple comprehension. Towards that end, Professor Gibson and Mr. Baker have taken us a stage of no mean degree, but much, very much, more remains to be done. It may, in fact, be said that, broadly speaking, they have done no more than reveal in a striking and interesting manner the wide complexities of the problem. It seems desirable, however, to repeat that at this stage the evidence they have collected, however detailed and convincing it may appear, should not hastily be accepted, without thorough experimental confirmation, as necessarily applying to other designs of engine operated under other conditions than those of the tests at Farnborough and Manchester on which Professor Gibson and Mr. Baker's data are based.

Engineers of the Future.

There was a time when the craft of engineers was engineering and nothing but engineering. A time when they troubled themselves as little as possible about business, which they wisely left to men with an aptitude for that pursuit; a time when industrial troubles were relatively few, when works were relatively small, and organisation relatively simple. Those times have gone, until the world, recovering from a cataclysmic change of its polar axis, returns once more to primal things and builds up with toil from the beginnings the art and science of mechanical engineering. Lamenting their departure is pleasant enough, but fruitless. We are tangled in the whirligig of the twentieth century, and no amount of praise of what in a worse seems a happier age will get us out of it. Willy-nilly we have to make the best of mechanical engineering as it is and be moderately thankful that, unless some unhappy discovery in biology extends life out of all reason, we shall escape the depressing condition which, by exterpolation of present observations, we may fairly say it is destined to attain. For, as we all know, the business man is beginning to dominate the engineer, and the engineer, in defiance of his natural propensities, is struggling with business in a fond attempt to maintain his status against the encroachment of men who know just about as much of engineering as he does of business.

The change began ten to twenty years ago. If our memory serves us, we ourselves did something to encourage it. We have recollections of saying with a boldness that received little encouragement then, but has since become an educational commonplace, that engineers must learn the elements of commerce and that commercial men must learn the elements of engineering. The desideratum that we called for has come. Schools of commerce have already been set up in our universities, and chairs of industrial economics will soon be established in some of our engineering colleges. Our young men, besides attempting to learn more science than can be reasonably packed into a three years' curriculum, will be expected to attend lectures upon, and pass examinations in, labour problems and the organisation of mass production factories. We may well look upon such a movement with some dubiety and encourage it with some hesitation. It is very doubtful if the young man of student age is fitted for some of the issues into which such studies must lead him. Workshop economics are not yet an exact science. The same facts lead to diametrically opposite opinions. The Socialist and Communist draw very different conclusions from those of the Conservative and Liberal. What, then, is the professor to teach? How is he to handle such a vexed question as piecework? Is he to show by formulæ and graphs that it is the ideal system dictated by science, or is he to present another side of it, show the workmen's objection to it, and exhibit the *argumentum ad hominem* with which labour leaders oppose it? What of the eight hours' day? Shall he accept and inculcate the views of Messrs. Thomas and Hodge or those of Sir Alfred Herbert? Is he, when he comes to larger economics, to express himself an ardent believer in trade amalgamations, with their gradual damping out of all save one or two dominant persons, or is he, in defiance of the movement of the age, to proclaim himself an individualist and prime his students with many glowing examples in support of his opinions? When we turn from professors to examiners our difficulties are in no sense diminished, for it takes a superhuman examiner to deal out even justice to views with which he is in radical disagreement. Indeed, such an one would be in the undignified position of continually having to acknowledge himself converted to divergent views as he alternately admitted the overwhelming force of the arguments of successive students, all equally talented and yet all violently opposed to each other. We hear of one of our great universities, which is always in the van of progress, that it has decided to burke examinations and will content itself with attendance at lectures. By so doing it will escape one difficulty, but not another. If its chair be filled by a sober economist, all its graduates will be damned by the labour leaders when they go to business; if, as seems improbable, it is filled by a Fabian, they will be worse damned by the sober economical employer, who, in dread of their tenets, will refuse to engage them. The fact is, that, struggle as you may, you cannot keep animosities out of labour economics, and it is open to serious doubt that it is wise to present either one aspect of them or another to very young men. Indeed, it may be held that the formation of views is best left to that period of the lives of engineers which must be spent in learning the technology of workshops and during which the observant apprentice acquires much other knowledge that is necessary to him. But it is said by employers that they cannot find young men with administrative ability. We do not doubt it; but we rather wonder that they should expect it. Certain we are that workshop administration is no more to be learnt at a university than Army and Navy administration is to be learnt at Sandhurst or Dartmouth. To those who have the aptitude it comes by experience; to those who have not it never comes. It may be said that we are taking too large a view, that there is a great deal of elemental work common to all workshop economics which can be readily studied; such matters as are covered under such headings as costing, Factory Acts, lighting, heating, ventilation, sanitation, timekeeping, welfare, and so on. We agree, but we are nevertheless doubtful that it is wise to rob hours from the all too short time that is available for technical and scientific studies and devote them to subjects which can be better acquired in the workshop itself, and that, as far as the engineer proper is concerned, will not be required until he has reached an age at which all his college-learnt views will have been modified or totally changed by living experience.

The present movement seems destined to call upon the engineer to fill two functions with injury to both. In course of time we hope to witness a return to a wiser plan. We hope, for example, to see the engineer-heads of our great factories allowed to devote all their talents to the improvement of technical processes, whilst the administrative work, the endless discussions with labour, the settlement of wages, costing, and even the progress of jobs through the shops, are left to men trained expressly for such duties. It seems to us deplorable that we should be told over and over again by clever engineers that they have little or no time to spend in their drawing-offices, that they cannot keep pace with technical progress, that they cannot invent or direct researches because the demands of labour conferences and business conferences make unceasing calls upon their time. If engineers cannot maintain their status as engineers without sacrificing engineering they are in a bad way. We suggest that they will in the long run do better by insisting on the status that is their right through their scientific and technical attainments than by seeking to secure it through incursions into functions that can be equally well, and perchance better, performed by non-technical men. The interchangeability of executive and engineer officers in the Navy has been dropped. Experiments both in England and America showed that it would not work. It seems probable that a wise division of duties will be found, in due time, as desirable in the factory as it is in the warship, and that once again the engineer will be able to devote his whole energy to scientific and technical advancements.

Literature.

Brassey's Naval and Shipping Annual, 1924. Edited by Sir Alex. Richardson and Archibald Hurd. (Wm. Clowes and Sons. 25s. net.)

This volume, the thirty-fifth of a series that began in the 'eighties of last century, appears at an opportune moment, when public opinion is once more occupied with questions of sea power. Recent events in the political world threaten to react on certain well-considered schemes of naval development which have not yet received the sanction of Parliament. The construction of a new dock and other base facilities at Singapore, which the Admiralty deems essential for the strategic mobility of the Fleet, was approved by the late Parliament, but it is not yet certain that the newly-elected House of Commons will vote the credits necessary for continuing a work which has been barely begun. Another Government measure that awaits the verdict of the House concerns the replenishment of the Navy with cruisers for the protection of commerce. These two schemes represent an effort to deal in practical fashion with the most urgent naval problems of the day. Full particulars of the Singapore project, together with a survey of the reasons which have induced the Government to bring forward a new shipbuilding programme, will be found in the new volume of "Brassey."

Twenty-four chapters, contributed in each case by writers of distinction, cover the whole range of Britain's maritime interests, present and future. Following the procedure first adopted in 1920, the book is divided into two sections: naval and mercantile. In the first section there are chapters on British and foreign naval developments during the past year. The Jutland controversy is the theme of a spirited essay by an anonymous writer, who endeavours, by comparing the various accounts of this battle, to correct the inaccurate impressions to which certain earlier versions gave rise. It is suggested that our heavy losses in the action were the result, not of faulty design or other shortcomings in *matériel*, but of circumstances which were not in every case under our control. For example, an experience early in the war had revealed to the Germans the danger of fire in the magazines arising from the flash of exploding shell. Profiting by this lesson, they took the necessary precautions, thereby preserving their ships from the fate that befell three of our battle-cruisers. We are not sure, however, that the author's explanation will convince those who have made a close study of this particular subject. Granting that the German anti-flash devices were superior to ours, it is nevertheless fairly obvious that other factors, such as the stability of ammunition and the method of stowing it, general design of gun-house and barbette, magazine flooding arrangements, &c., would have to be weighed before it was possible to reach a final verdict. This article, however, is of especial value because it rivets attention on a technical aspect of the Jutland dispute which has not hitherto received the notice it deserves. The ease with which some of our most powerful ships were destroyed by gun-fire is a mystery which has never been satisfactorily explained.

Mr. H. G. Williams, of Sir W. G. Armstrong, Whitworth and Co., Limited, has some interesting remarks to offer on the design of aircraft-carriers, a type of vessel of which the growing importance is attested by present-day construction policy in this country and abroad. Tentative designs are submitted for ships that would probably meet all requirements without exceeding the Treaty limit of displacement. High speed and ample capacity for the carriage of aircraft are the two chief desiderata in these vessels. The supposed vulnerability of the capital ship to air and submarine attack suggests to Mr. Williams "the possibility of building aircraft carriers which would rank as capital ships." But if the strongly protected

HUMPHREY PUMPING PLANT AT COBDOGLA, SOUTH AUSTRALIA

WILLIAM BEARDMORE AND CO., LIMITED, GLASGOW, ENGINEERS

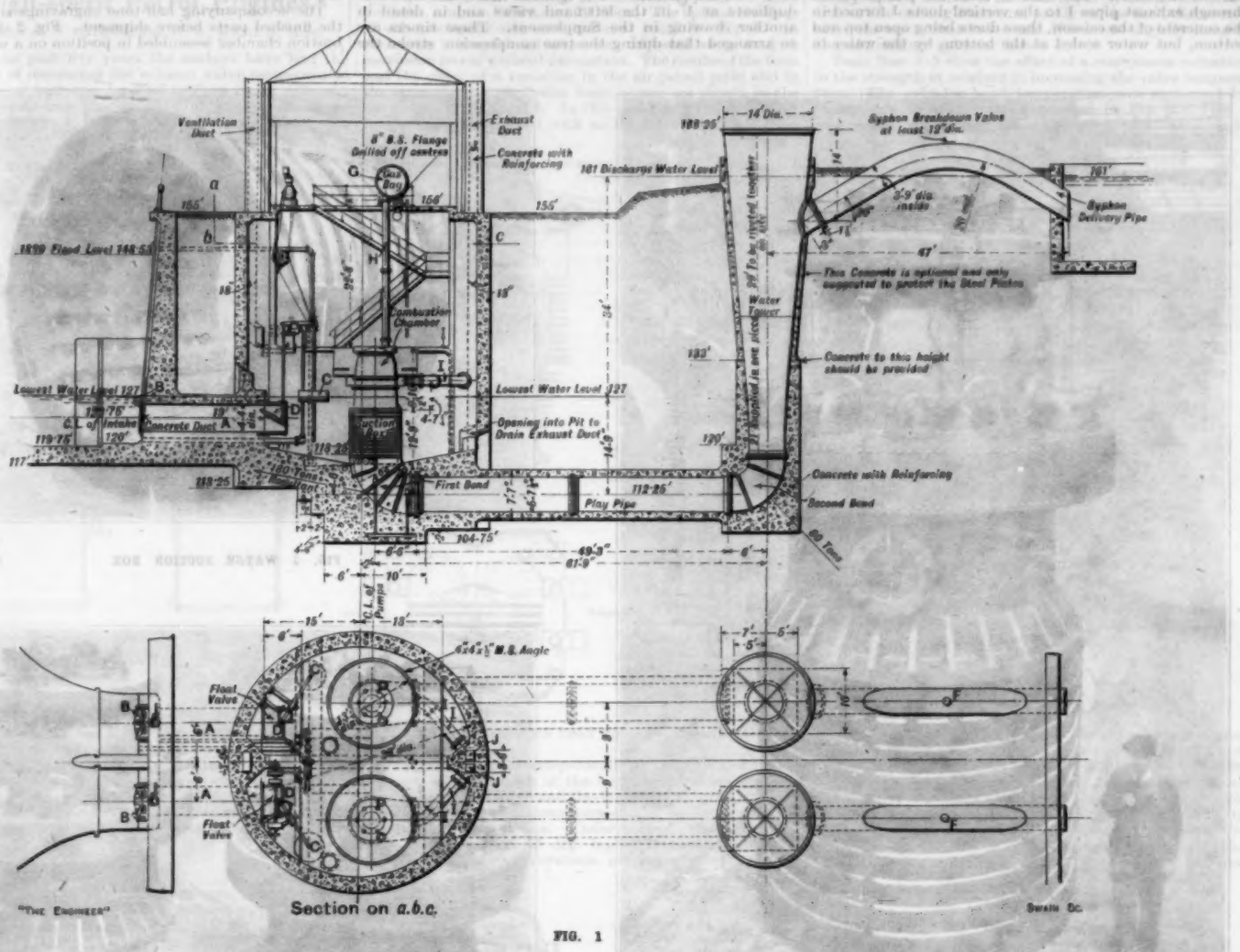


FIG. 1

and well-armed battleship cannot hold its own against the new weapons, would not an aircraft carrier of equal dimensions be far more vulnerable? It seems to us that every argument against perpetuating the battleship applies with redoubled force to the large and less well-protected aircraft carrier.

Another article certain to be read with deep interest is that of Brigadier-General Bagnall-Wild on the trend of research and design in aircraft engineering. The importance of aero-dynamic research is rightly stressed, and a concise summary is given of the directions in which improvement is to be looked for. Professor W. H. Eccles writes with intimate knowledge on the progress of directional wireless, which played such an important, even a decisive part, in the late war, and has now been diverted to peaceful use in the interests of safe navigation. The various systems of electric propulsion for ships and the future possibilities of this method are outlined by Mr. L. Miller, whose faith in it, however, does not blind him to its drawbacks. He makes none of the large claims which have been put forward by American advocates of the electric drive, apparently on insufficient evidence. We welcome the inclusion of a paper on the Institution of Naval Architects, by Mr. R. W. Dana, its zealous and popular secretary. Naval architecture owes a profound debt to this Institution, which has done invaluable work for two generations in fostering the production of efficient ships for every purpose.

In the Merchant Shipping Section the economics of shipping take precedence over technical questions, though the latter are by no means ignored. Mr. James Richardson contributes his usual authoritative survey of marine engineering progress, paying due regard to the steady advance of the internal combustion engine, an advance which has happily not been seriously checked by the depressed state of our industries since the war. This chapter ends on a refreshing note of optimism, for Mr. Richardson is sure that "those great qualities of initiative, enterprise, and, above all, courage, which have built up British shipowning and shipbuilding, will again rise supreme, and lead to a return of prosperity in all departments catering for the carrying of the world's cargoes."

The statistical and documentary material which adds so much to the value of "Brassey" as a work of reference is, as always, comprehensive and well arranged. Nor must a word of praise for the pictorial matter in the book be omitted. The latest ships of war and commerce are illustrated by photographs or drawings, the ship silhouettes are carefully prepared with a view to assisting identification, and the men-of-war diagrams have been redrawn by a practised hand. It is clear that the editors have spared no pains to enhance the utility of the book, which, under their able direction, is gaining appreciably year by year in value and reputation.

BOOKS RECEIVED

Technical Arithmetic. By R. W. M. Gibbs. London: Blackie and Son, Limited, 50, Old Bailey, E.C. 4. Price 3s. 6d. net.

The Problems of the Obelisks. By R. Engelbach. London: T. Fisher Unwin, Limited, 1, Adelphi-terrace, W.C. 2. Price 9s. net.

Engineering Mathematics, Part I. By R. W. M. Gibbs. London: Blackie and Son, Limited, 50, Old Bailey, E.C. 4. Price 1s. 6d. net.

Mechanical Staking. By David Brownlie. London: Sir Isaac Pitman and Sons, Parker-street, Kingsway, W.C. 2. Price 5s. net.

Capital and Steam Power, 1750–1800. By John Lord. London: P. S. King and Son, Limited, Orchard House, Westminster, S.W. 1. Price 7s. 6d. net.

Lathes, their Construction and Operation. By G. W. Burley. London: Scott, Greenwood and Son, 8, Broadway, Ludgate, E.C. 4. Price 7s. 6d. net.

Conférences de Chimie Minérale (Métaux), faites à la Sorbonne. By Marcel Guichard. Paris: Gauthier Villars, 55, Quai des Grands Augustins. Price 30f.

The Smoke Inspector's Handbook on Economic Smoke Abatement. By Herbert G. Clinch. London: H. K. Lewis and Co., 28, Gower-place, W.C. 1. Price 7s. 6d. net.

Engineering Science. By A. G. Robson. The D. U. Technical Series. London: Chapman and Hall, Limited, 11, Henrietta-street, Covent Garden, W.C. 2. Price 7s. 6d. net.

The Law of the Car, Private and Commercial. By L. G. Redmond-Howard and Harold Crane. London: Percival Marshall and Sons, 66, Farringdon-street, E.C. 4. Price 2s. 6d. net.

Clouds and Smokes. The Properties of Disperse Systems in Gases and their Practical Applications. By William E. Gibbs. London: J. and A. Churchill, 7, Great Marlborough-street, W. 1. Price 10s. 6d. net.

The Metallurgy of Steel—Vol. I., Metallurgy; Vol. II., Mechanical Treatment. By F. W. Harbord and John W. Hall. London: Charles Griffin and Co., Limited, Exeter-street, Strand, W.C. 2. Price 32s. each volume.

Lead: Its Occurrence in Nature, the Modes of its Extraction, its Properties and Uses, with Some Account of its Principal Compounds. By J. A. Smythe. London: Longmans, Green and Co., 39, Paternoster-row, E.C. 4. Price 16s. net.

Large Humphrey Pumps for Australia.

In our issue of March 4th, 1921, we showed some reproductions of photographs of, and made a brief reference to, the large installation of Humphrey pumps for the Metropolitan Water Board at its pumping station, King George V. Reservoir, near Enfield Lock, Middlesex. Entirely owing to the war, and to the unsettled condition of things since, whilst some experimental work has been done, no further large installations of Humphrey pumps have been undertaken, but we are now very glad to note further development of this most interesting system of pumping.

The well-known firm of William Beardmore and Co., Limited, of Glasgow and London, some time ago took over the manufacturing rights from the Humphrey Pump Company, Limited, and by its courtesy we are now able to give particulars of a large Humphrey pumping plant, which it is supplying to the South Australian Government. The installation consists of two pumps of a combined pumping capacity of 2,857,500 gallons per hour. The pumps are identical, and each has a capacity of 24,800 gallons per minute. Thus, they are somewhat smaller than the large pumps for Chingford, the play pipes being 5ft. 6in. in diameter, as compared with 6ft. at Chingford.

We understand that the pumps are required for irrigation purposes at Cobdogla, which is situated about 180 miles up the river Murray. Owing to the fact that the river level rises and falls, according to the season, a matter of 20ft., the combustion chambers are arranged side by side in a concrete circular caisson, 36ft. internal diameter, in the bottom part of which are formed separate suction sumps, as may be seen in Fig. 1, which shows the installation in elevation and plan. The water is led through the concrete ducts A from the river into the pump sumps, penstock valves being provided at B, to isolate the respective pump sumps from the river. The water level in the sumps is controlled automatically by floats, shown at C, which operate the butterfly valves D, and a dashpot is incorporated in each float-governed valve to prevent sudden movements which might give rise to water shock in the concrete ducts. The water is finally delivered from the water towers through syphons to the irrigation canal E. By opening the air valves at F, shown on top of the syphons, air is permitted to enter, thus destroying the syphon action, and completely isolating the pumps from the delivery canal without the necessity of employing sluice valves.

The pumps themselves are of the four-stroke type, the operation being exactly similar to that of the Chingford pumps. Although the pumps are, as already mentioned, a little smaller than the large Chingford pumps, it has been thought wise to keep the proportions as nearly the same as possible. In matters of detail, however, some departures have been made.

We have no particulars of the gas plant, which is being

supplied locally, but we understand that the gas will be produced from wood, the calorific value being about 135 B.Th.U. per cubic foot. This gas passes to the gas bags shown at G, and thence through pipes H to the combustion chambers. The exhaust from the pumps passes through exhaust pipes I to the vertical ducts J formed in the concrete of the caisson, these ducts being open top and bottom, but water sealed at the bottom by the water in the pump sumps. By this arrangement the little water which escapes through the exhaust valves is immediately returned to the suction sump.

For the purposes of starting the pumps, which is effected by forcing into the combustion chamber an initial volume of gas and air and igniting by hand, there is a small two-cylinder belt-driven compressor, operated by a small petrol-paraffin engine, which is also available to drive the centrifugal pump for draining the pump sumps when necessity arises to have access to the water valves. Since no excessive pressures have ever been recorded with the Chingford pumps, it has been found possible to dispense with cast steel for the combustion chambers, the main castings being now of cast iron. For the same reason, it has not been considered necessary to provide safety valves like those at Chingford, to relieve excessive pressures.

The combustion chambers are internally of similar shape to those of the Metropolitan Water Board's units, and the various valves, mixture, scavenging, air and exhaust are arranged in similar positions. The two drawings on the left-hand side of our Supplement show respectively an elevation, partly sectional, of the upper part of, and a plan of a combustion chamber. The inlet valves shown at K draw their supply of gas from the ring duct L, which is made in one casting and bolted to the combustion chamber, thereafter forming an integral part of same. The gas is admitted to this duct through two pipes M, each governed by a regulating valve N. A certain amount of air is drawn into the combustion chamber through the inlet valves, and air valves O communicating with the duct L are provided for that purpose. Scavenging air, with which the combustion chamber is flushed immediately after the expanded products reach atmospheric pressure, is admitted through valves P. A drawing of a scavenging air valve, which in size and construction is very similar to an inlet valve, is also given in the Supplement. Owing to the very low temperature which prevails in a Humphrey pump, and the fact that the combustion chamber is flushed with water, it is possible to provide all the valves in the combustion chamber with rubber faces, similar to that shown at Q. The valves are thereby rendered extremely tight, and all shock is eliminated. Instead of having to regrind seats, all that is necessary is to renew the rubber faces, on the lines of the renewal of ordinary tap washers.

The inlet valves and the scavenging valves are each provided with safety check valves R. If for any reason one of these valves fails to close, owing to sticking or to the breakage of the closing spring S, these check valves, which are very light, are immediately blown on to their seats by the escaping gas.

The interlocking gear, which operates in the same manner as that at Chingford, is operated by the mechanism shown at T—see Supplement. The ignition timers are shown in duplicate at U in the left-hand views and in detail in another drawing in the Supplement. These timers are so arranged that during the true compression stroke the spring-loaded piston V rises when the ignition pressure is reached, and makes electrical contact between arm W and contact piece X, but during the next inward stroke of the pump, when ignition is not necessary, although the spring-loaded piston V rises again, the mechanism prevents the ignition circuit being closed, and thus reduces the consumption of current. The small switch at Y on the left of the ignition timing apparatus is for the purpose of starting the pump by hand firing.

The water suction boxes are very little different from those at Chingford. The main casting is shown in Fig. 5. The valves themselves are made of phosphor bronze, and are of the hinge type with vertical spindles, and are closed by spiral springs. The seats are also of phosphor bronze bolted to the main casting. The right-hand bottom drawing in the Supplement shows a number of valves and seats in position. The valves are somewhat larger than those at Chingford, and there are proportionately a smaller number.

The accompanying half-tone engravings show some of the finished parts before shipment. Fig. 2 shows a combustion chamber assembled in position on a water suction box; Fig. 3 shows a water suction box lying horizontally with some of the valves in position; while Fig. 4 shows another view of the two combustion chambers taken from a higher position, so that the gas, air and scavenging valves can be seen. These engravings give a very good idea of the size of the installation. We may add that the bare weights of the combustion chamber and of the suction water box are 10 and 12½ tons respectively.

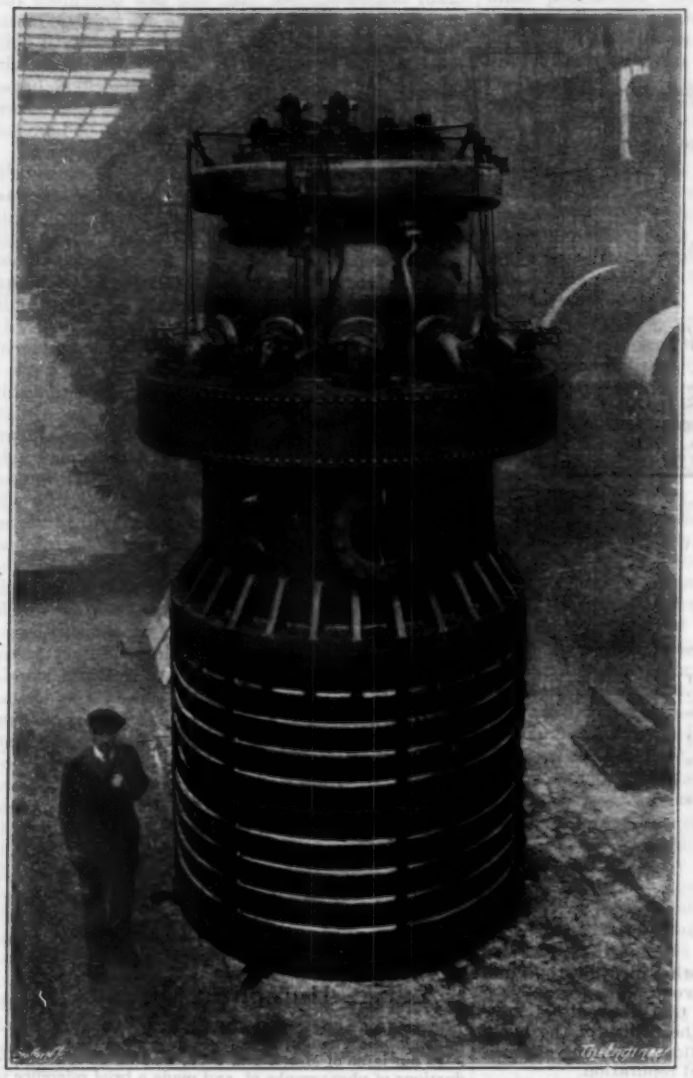


FIG. 2—COMBUSTION CHAMBER ON WATER SUCTION BOX

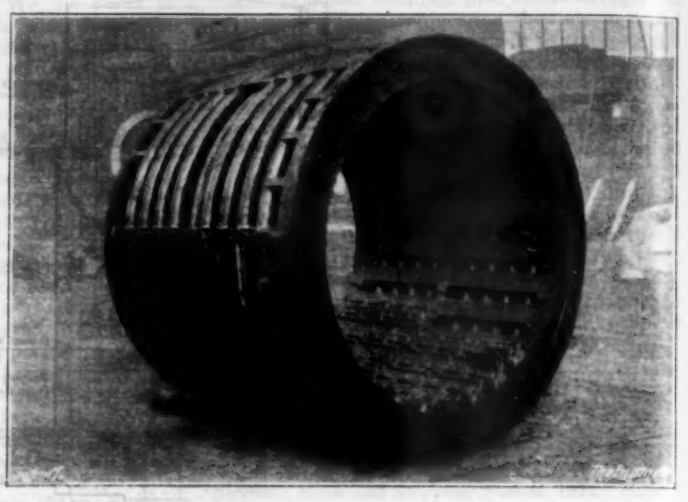


FIG. 3—WATER SUCTION BOX

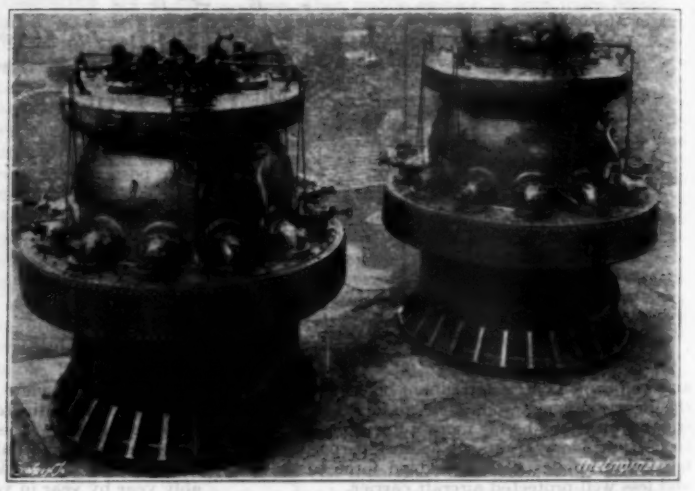


FIG. 4—TWO COMBUSTION CHAMBERS

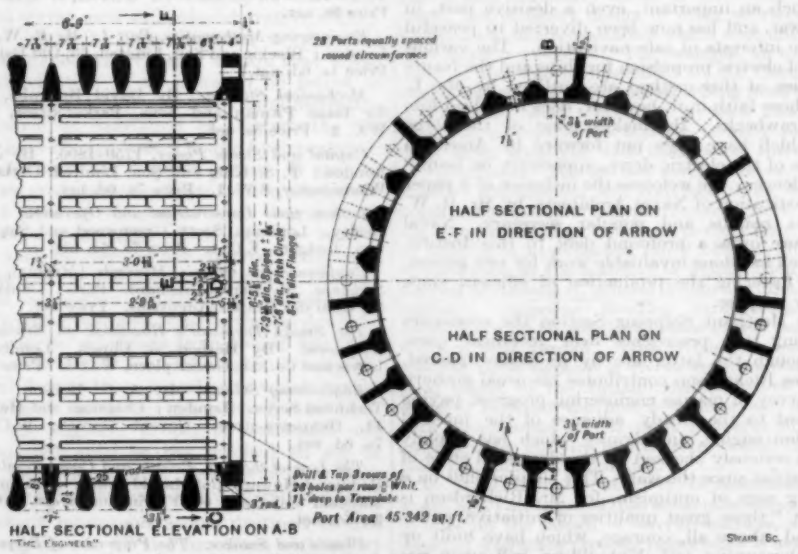

28 Ports equally spaced round circumference
HALF SECTIONAL PLAN ON E-F IN DIRECTION OF ARROW
HALF SECTIONAL PLAN ON C-D IN DIRECTION OF ARROW
HALF SECTIONAL ELEVATION ON A-B
Port Area 45·342 sq. ft.

FIG. 5—SECTIONS OF WATER SUCTION BOX

It is proposed to build a temporary wooden bridge across the Middle Harbour, Sydney, Australia, at a cost of between £40,000 and £60,000.

Exhaust Valve and Cylinder Head Temperatures in High-speed Petrol Engines.*

By Professor A. H. GIBSON and H. W. BAKER, M.Sc.

DURING the past five years the authors have had the opportunity of measuring the exhaust valve temperatures in a number of high-speed petrol engines under different operating conditions. A number of these tests were carried out on the cylinders of aero-engines during the development work at the Royal Aircraft Establishment, and these have been largely extended by the results of an investigation in the engineering department of the Manchester University on a single-cylinder water-cooled unit presented by Armstrong Siddeley Motors, Limited. The tests were designed with a primary view of determining the effect on the exhaust valve temperature of the following variables :—

(1) Strength of working mixture.
(2) Power output.
(3) Compression ratio.
(4) Speed.
(5) Spark advance.
(6) Cylinder jacket water temperature.
(7) Position of admission of cooling water to cylinder jacket.
(8) Shape of valve.
(9) Width of valve seat. Cooling effect of valve seat and guide.
(10) Lift of valve.
(11) Valve tappet clearance.
(12) Type of fuel—petrol and 20 per cent. benzol-petrol mixture.

The cylinders tested were all of the overhead valve type.

Experimental Apparatus.—In all the tests, the brake horse-power was measured by a Froude hydraulic brake. In the tests at the University and in a number of the tests at the R.A.E., the air-petrol ratio was deduced from air-box measurements, for which Watson's orifice coefficients have been used. The petrol consumption was regulated by a Claudel Hobson carburetter fitted with a simple needle-adjusted jet. Variations in the compression ratio were effected by the insertion of packing pieces between the cylinder and crank case. In the tests on the water-cooled cylinders, cooling water was supplied from the town's mains. In the tests at the R.A.E. the fuel was Shell aviation spirit, while in the University tests Pratt's No. 1 motor spirit—specific gravity 0.724 at 15 deg. Cent. —was used, except in a series of comparative tests, when the fuel consisted of a mixture of 80 per cent. petrol and 20 per cent. benzol.

Measurement of Exhaust Valve Temperatures.—After many attempts, the type of thermo-couple due to Mr. D. Heron—shown in Fig. 7—was devised and used with success. Owing to the impossibility of using thermo-couples in the valves of engines undergoing routine tests, it was decided to use the results of the tests on this installation to test the accuracy for measurement of valve temperatures of the type of optical pyrometer known as the "Pyromike." In these tests the engine was run with open exhaust, and the pyrometer was sighted through the exhaust port on to the upper side of the valve head at a point midway between the stem and the edge of the valve. The general results of the tests were such as to indicate that with care the instrument is capable of giving exhaust valve temperatures which are probably within 10 deg. Cent. of being accurate. For the tests at the University a "Shore" pyroscope was used. With this instrument the intensity of the light radiated from the heated exhaust valve is matched with the light intensity of a standard paraffin flame modified at will by the use of a calibrated iris diaphragm of red celluloid. It was found that comparatively few points on the valve temperature diagrams lay more than 10 deg. Cent. from the mean smooth curves.

Measurement of Cylinder Head Temperatures.—For the determination of cylinder head temperatures, thermo-couples of copper-constantan—Fig. 8—were used. These were screwed into the metal walls from inside the cylinder. A common cold junction was provided in an ice flask. A number of couples were also placed in the water space, and one in the exhaust valve guide.

Experimental Data.—Air-cooled Cylinders : (a) *Single Aluminium Air-cooled* 100 *mm. Bore Cylinder* (*Fig.* 1).—These tests were carried out with a compression ratio of 5.5 at 1800 and 2000 revolutions per minute over a wide range of air-petrol ratios. The air temperature was 19 deg. Cent., the velocity of the cooling wind 62 miles per hour, and the barometer 29.65in. The optical readings of valve temperatures were taken at point A—Fig. 7. In each case the spark advance was adjusted so as to give maximum power without detonation. The results of the tests and the effect of a variation in the air-petrol ratio and in the consumption per brake horse-power are shown in the curves of Fig. 9, *a* and *b*. In this case the maximum valve temperature is attained with an air-petrol ratio of about 15 : 1, and the maximum head temperature with a ratio of about 13.5 : 1.

It appears that the temperature of the cylinder head, measured at the centre of the head, only varies slightly with the air-petrol ratio, and this is confirmed by the figures given for the mean temperature of the cooling surfaces, including the cooling fins. Under normal conditions, the valve temperature is 15 deg. higher in this cylinder at 2000 than at 1800 revolutions per minute. With the cooling wind cut down until continuous pre-ignition takes place, the temperature rises to 805 deg. Cent. Under such conditions, a tungsten steel valve scales badly and rapidly burns out. Tests on a similar cylinder in which the exhaust valve seat was loose gave valve temperatures of 810 deg, unaccompanied by pre-ignition. In this case the valves, of tungsten steel, burned out after about one hour's operation on full throttle.

(*b*) *Single Aluminium Air-cooled* 5½*in. by* 6*in. Cylinder* (*Fig.* 2).—These tests were carried out with a compression ratio of 5.05 at 1700 revolutions per minute, with an air temperature of 17 deg. Cent., a wind speed of 70 miles per hour, and a barometer of 29.85in. The results are shown in Table I. In this cylinder, valve No. 1 was always hotter than No. 2. This is partly due to the direction of the cooling blast and partly to the fact, discovered after the tests, that valve seat No. 1 was slightly loose in the aluminium cylinder head.

Tests Nos. 1–5 show the effect of a continuous reduction in the strength of mixture in increasing the valve temperature. The cylinder head temperature was measured by thermo-couple at the point marked in Fig. 2. Test 6 was carried out to determine the effect of a variation in the position of the sparking plugs. The cylinder is provided with four plug holes in pairs, diametrically opposite and adjacent to the four valves. In each test two diametrically opposed plugs were used. In Tests 1–5 the diametrical plane containing them also passes through exhaust valve No. 1, so that one plug is underneath, and the other directly opposite this valve. In Test 6 the plane containing the plugs was at right angles to its previous position, so that one plug is now underneath and one opposite exhaust valve No. 2. The effect of the change of plug positions is very marked. The position in Test 6 enables the same power to be developed on a lower petrol consumption. At the same time the temperature of valve No. 1 is considerably reduced and that of valve No. 2 is increased.

TABLE I.

Test.	B.H.P.	B.M.E.P.	Petrol, pints per B.H.P. hour.	Spark advance (two plugs).	Max. cylinder head temp. T.	Exhaust valve temperatures.	
						No. 1.	No. 2.
				Deg.	°C.	°C.	°C.
1	35.9	117.2	0.727	15	295	580	Well below 600
2	35.3	115.2	0.647	14	320	630	
3	34.7	113.2	0.620	12	317	630	
4	33.2	108.6	0.618	12	312	670	
5	32.2	105.2	0.621	12	309	660	
6	34.3	112.2	0.591	12	295	610	590

(*c*) *Single Air-cooled Cylinder,* 5½*in. by* 6½*in., Compression Ratio* 5.0 (*Fig.* 3), *with Single Exhaust Valve* 2.3*in. diameter.*—Only one series of measurements were made on this valve, with the following results :—

Revs.	B.M.E.P.	Petrol, pints per B.H.P. hour.	Maximum cylinder head temps.	Exhaust valve temps.	Remarks.
			Deg. C.	Deg. C.	
1650	113.4	0.621	242	760	Maximum load conditions
1650	111.6	0.541	262	790	Maximum thermal efficiency

In these tests the air speed was 80 miles per hour and the air temperature 18 deg. Cent.

(*d*) *Single Steel Air-cooled Cylinder,* 5½*in. by* 6½*in.* (*Fig.* 4). —Only a few valve temperatures were measured on this

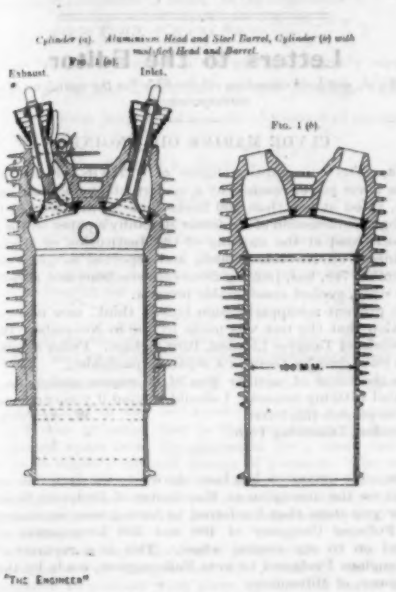


FIG. 1 (b).

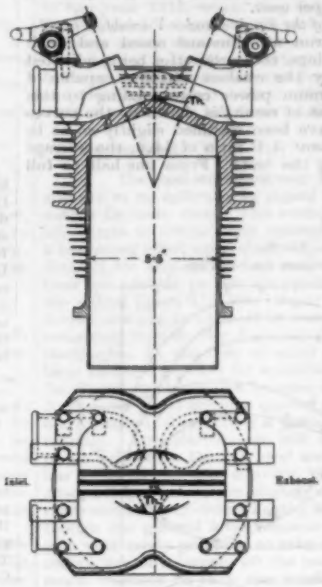


FIG. 2.—Cylinder (b). Aluminium Head and Steel Barrel.

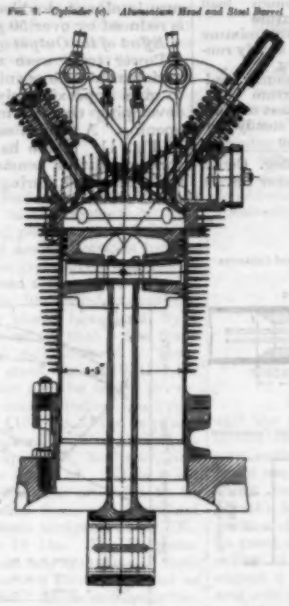


FIG. 3.—Cylinder (c). Aluminium Head and Steel Barrel.

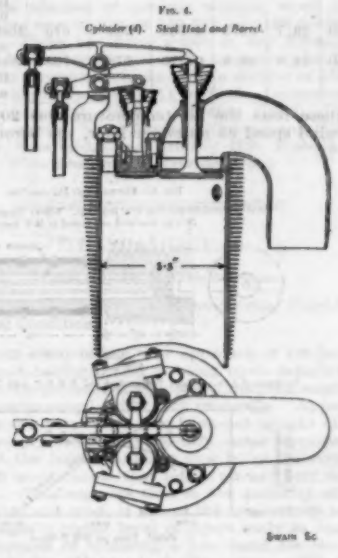


FIG. 4.

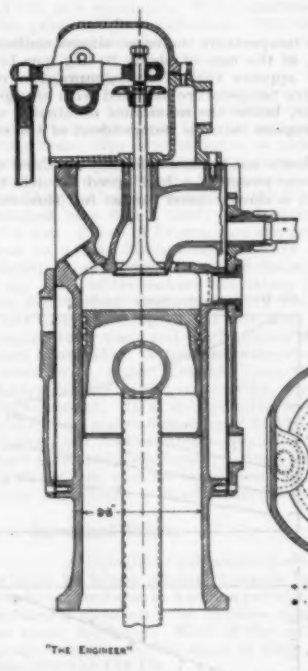


FIG. 5.
Standard 50-H.P. Water Cooled Cylinder.
(Armstrong-Siddeley.)

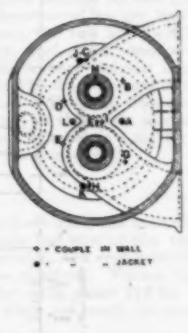


FIG. 6.
Cylinder Head. Section below Flange.

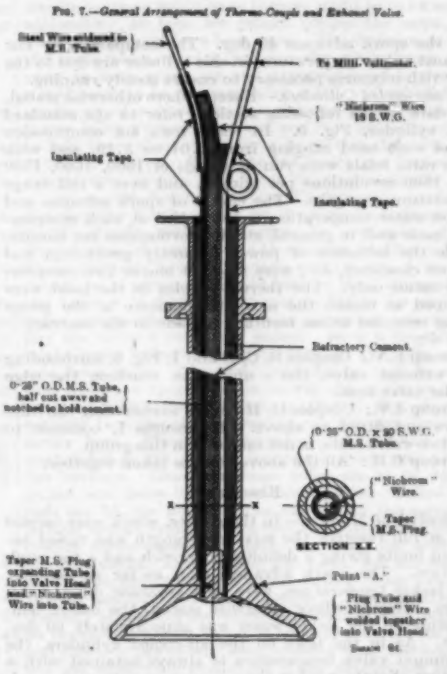

Steel Wire soldered in M.S. Tube.
To Millivoltmeter.
"Nichrom" Wire 19 S.W.G.
Insulating Tape.
Insulating Tape.
Refractory Cement.
0·28" O.D. M.S. Tube, half cut away and notched to hold cement.
0·28" O.D. x 20 S.W.G. M.S. Tube.
"Nichrom" Wire.
Taper M.S. Plug.
SECTION X.X.
Taper M.S. Plug expanding Tube into Valve Head and "Nichrom" Wire into Tube.
Point "A."
Plug Tube and "Nichrom" Wire welded together into Valve Head.
BRAIN &c.

FIG. 7.—*General Arrangement of Thermo-Couple and Exhaust Valve.*

* The Institution of Mechanical Engineers.—Abstract.

cylinder. These were taken with the petrol reduced to give the weakest mixture capable of developing maximum load, and with the weakest mixture at which steady running was possible. The cylinder head temperatures were measured at the exact centre—approximately the hottest point—of the head. The results are given in Table II.

Table II.

Revs.	B.H.P.	B.M.E.P.	Petrol, pints per B.H.P. hour.	Cyl. head temps.	Exh'ust valve temps.	Remarks.
				Deg. C.	Deg. C.	
1450	28.1	99.1	0.955	270	680	Maximum load mixture
1450	27.5	97.0	0.795	290	690	Weakest mixture for steady running
1650	29.7	92.5	1.062	254	675	Maximum load mixture
1650	28.6	88.8	0.770	278	705	Weakest mixture for steady running

In these tests the air temperature was 20 deg. Cent., the wind speed 85 miles per hour, the barometer 29.40,

Fig. 8.—*Thermo-couple Hot Junction.*

Head restored by grinding after insertion. Wires: Copper and Constantan 30 w.g., insulated and brazed to M.S. body

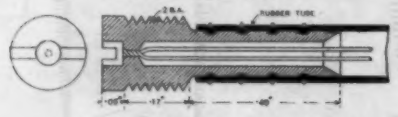


Fig. 9a.

Variation of Exhaust-Valve Temperature and B.M.E.P. with Petrol Consumption

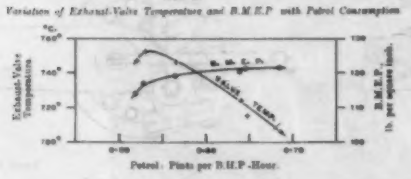


Fig. 9b.

Variation of Exhaust-Valve Temperature and B.M.E.P. with Air-Petrol Ratio.

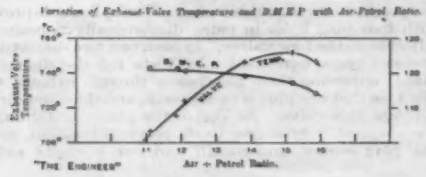
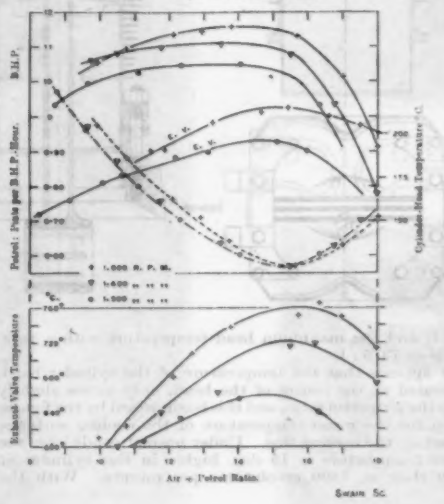


Fig. 10.

Standard A.S. Cylinder Full Throttle Tests.



and the spark advance 40 deg. The comparatively low exhaust valve temperatures in this cylinder are due to the very rich mixtures necessary to ensure steady running.

Water-cooled Cylinders.—Except where otherwise stated, the data in the following sections refer to the standard A.S. cylinder, Fig. 5. In these tests six compression ratios were used ranging from 4.01 to 5.19, and with each ratio trials were run at speeds of 1500, 1600, 1700 and 1800 revolutions per minute, and over a full range of mixture strengths. The effects of spark advance and jacket-water temperature were studied at each compression ratio and, in general, at 1800 revolutions per minute, while the influence of power (quantity governing) and tappet clearance, &c., were made at one or two compression ratios only. The thermo-couples in the head were grouped as under, the mean temperature of the group being recorded unless mention is made to the contrary—Fig. 6:

Group E.V.: Couples B, C, D and I, Fig. 6, surrounding the exhaust valve, the couples just touching the edge of the valve seat.

Group I.V.: Couples G, H and E, surrounding the inlet valve and fitted as above. The couple I, common to the two valve seats, is not included in this group.

Group C.H.: All the above couples taken together.

Results.

Strength of Mixture.—In these tests, which were carried out at full throttle, the mixture strength was varied between limits giving a definitely over-rich and a too weak mixture. The spark advance, and, as far as possible, the jacket temperature, were kept constant during each series. Except where otherwise stated, the outlet temperature on the jacket water was approximately 60 deg. Cent. As in the tests on the air-cooled cylinders, the maximum valve temperature is always attained with a mixture slightly weaker than is necessary to give maximum power, and is from 20 deg. to 30 deg. higher than that attained with the latter mixture.

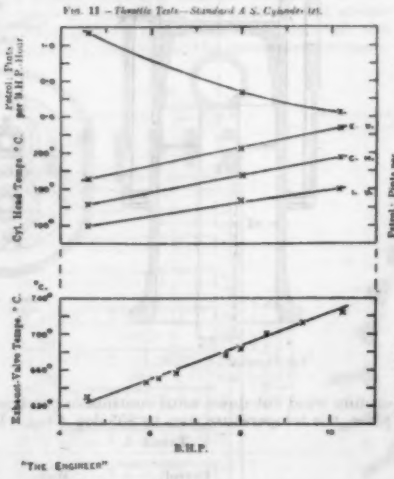
The temperature of the valve first becomes measurable with an air-petrol ratio of about 11 : 1, rising to a maximum with a mixture of about 15.5 : 1 and then falling rapidly as the mixture is still further weakened. The exact A/P ratio giving the maximum temperature varies somewhat with the speed. At 1500 revolutions per minute it is 14.5 : 1, and at 1800 revolutions per minute is 15.5 : 1. It appears to be sensibly independent of the compression ratio. The curves for cylinder-head temperatures follow very closely the form of those for the exhaust valve, but have maxima with somewhat richer mixtures, the maximum head temperatures being attained very nearly with the weakest mixtures capable of developing maximum power, as in the case of the air-cooled cylinders.

The range of cylinder-head temperatures is considerably less than that of the exhaust valve, being about one-fifth of the valve range at 1500 revolutions per minute and one-fourth at 1800 revolutions per minute for group E.V., and slightly less for the other two groups. This also is in general agreement with the results of measurements on the air-cooled cylinders. The general influence of mixture strength on exhaust valve and cylinder-head temperatures is shown by the curves of Fig. 10, which refer to a compression ration of 4.77.

Indicator cards were taken and their height and uniformity are greatest with the weakest mixture capable of giving maximum power, and that the time from the passage of the spark to the attainment of maximum pressure is then a minimum—about 0.0053 sec. A variation of the A/P ratio from 14.5 : 1 to 9.7 : 1 increases the time of explosion by 18 per cent. and decreases the brake horse-power by about 6 per cent. The effect of weakening the mixture is very marked. With the mixture giving maximum efficiency the time to reach maximum pressure is increased 24 per cent., and the mean effective pressure is decreased some 15 per cent., while with the weakest mixtures used the time to reach maximum pressure is almost doubled, and the mean effective pressure is reduced by over 50 per cent.

Effect of the Output of the Engine under Variable Throttle.—Power tests were run at constant speed and with variable throttle openings, the carburetter being adjusted to give approximately the weakest mixture capable of developing the maximum power corresponding to this opening. A typical set of results is shown by the curves of Fig. 11. These have been modified slightly so as to correspond to a constant A/P ratio of 14.5, the average ratio obtained during the tests. From one-half to full power, the valve temperature increases almost uniformly with the output, at the rate of about 20 deg. per brake horse-power. It appears that if the compression ratio is varied, the valve temperature attained with any given brake horse-power, below the maximum obtainable with the lowest compression ratio, is independent of the compression ratio.

Fig. 11.—*Throttle Tests—Standard A.S. Cylinder (cf).*



The relatively lower mechanical efficiency obtained with a given brake horse-power in a high-speed throttle test, as compared with a slower speed but at full throttle, is a further factor tending to modify the results in the direction indicated by the experiments.

Compression Ratio.—The compression ratios used, ranging from 4.0 to 5.2, sufficiently cover both extremes for the cylinder under test, the power available at the lower compression being below that reasonably attainable, while at the highest ratio detonation is well marked and regular. No detonation was detected at the ratio of 5.07, except at comparatively low speeds.

The curves of Fig. 12 show the maximum temperatures attained at full throttle with the weakest mixture capable of giving maximum power, and at 1650 and 1800 revolutions per minute respectively. If these curves be modified by making an allowance of 20 deg. Cent. per horse-power of increased output, as deduced from the throttling tests, it appears that the valve temperature for a given output is sensibly independent of the compression ratio.

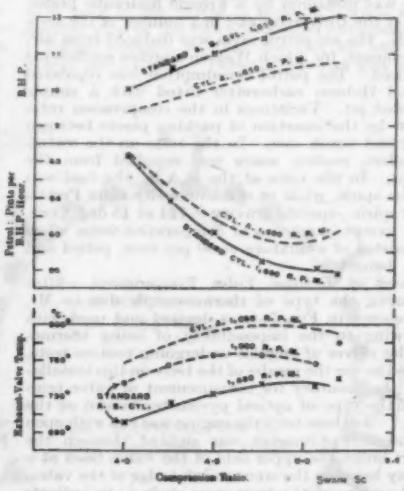
The corresponding curves of cylinder-head temperature show a small rise amounting to about 10 deg. Cent. for group E.V. over the whole range of compressions. When modified for the effect of the increased power at the higher ratios, these temperatures, for a given output, are also sensibly independent of compression ratio.

For comparison the results of similar tests on the modified cylinder—called cylinder A—are also shown on Fig. 12. The effect of the hotter head is shown in a reduction in power of about 10 per cent., and an average increase of 65 deg. Cent. in the valve temperatures in spite of the reduced output. The petrol consumption, which is sensibly the same at the lowest compression ratio, is 8 per cent. higher than in the standard cylinder at the highest ratio.

(To be continued.)

Fig. 12.

Effect of a variation in Compression Ratio on Standard A.S. Cylinder.


B.H.P.
STANDARD A. S. CYL. 1,650 R. P. M.
CYL. A. 1,650 R. P. M.
Petrol - Pints per B.H.P.-Hour.
CYL. A. 1,800 R. P. M.
STANDARD CYL. 1,800 R. P. M.
Exhaust-Valve Temp.
CYL. A. 1,650 R. P. M.
1,800 R. P. M.
1,650 R. P. M.
STANDARD A. S. CYL.
Compression Ratio.
Swain Sc

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

CLYDE MARINE OIL ENGINES.

Sir,—The consumption figure of 0.386 lb. of fuel oil per brake horse-power reached by a modern oil engine, cold starting type, rated at less than 100 brake horse-power, quoted by me during the discussion of Professor Mellanby's paper on the above subject, read at the meeting of the Institution of Mechanical Engineers on November 30th, and reported in your issue of December 7th, has, judging from conversations and correspondence since, evoked considerable interest.

To prevent misapprehension it is, I think, now necessary to mention that the test was made by me in November, 1922, at the works of Tangyes Limited, Birmingham. Fuller details have been published by them in a separate pamphlet.

As the name of another firm of oil engine makers has been coupled with my remarks, I should be glad if you could see your way to publish this letter. W. A. Tookey.

London, December 13th.

Sir,—My attention has been drawn to the fact that in your report on the discussion at Manchester of Professor Mellanby's paper you state that I referred to having seen an example by the Fullagar Company of 400 and 500 horse-power engines geared on to one central wheel. This is a reporter's error. The engines I referred to were Falk engines, made by the Falk Company, of Milwaukee.

Hazel Grove, Stockport, December 18th. Chas. Day.

THE GAS TURBINE.

Sir,—Your issue of yesterday's date, the 14th inst., contains a thoughtful article on the above subject, in which Mons. Jules Descamps draws attention to possible variations of the theory applicable to the internal combustion turbine from that appertaining in general to all heat engines. It is indisputable that the complex exchanges of heat taken in conjunction with the variations in chemical state of the gases, render a departure from a simple theory inevitable, but with your permission I would like, as one of those who believe in the near possibility of a successful internal combustion turbine, to put forward some remarks relative to the general theory.

First, it should be postulated that whatever divergence may be entailed owing to the physical properties of a working fluid, and to the limitations imposed by mechanical considerations, the fundamental principles of thermodynamics are immutable. They are founded on facts and reasons. It may be that new gaseous properties will be added to those already known; but the Carnot conception of a working cycle between upper and lower temperature limits stands with the laws of thermodynamics as the basis of all heat engine work. The gas turbine working fluid must, no matter what cycle of operation is chosen, work within the framework of the same laws that surround the piston engine fluid. There is no other theory peculiar to the turbine that cannot be applied to the piston engine.

It was implied that the work of compression in a piston engine was less than that required for a constant pressure turbine, in the ratio of γ, but a little thought will make it clear that in the latter case the work of delivery in the negative compression cycle reappears as positive work in the turbine cycle. The closed path work cycle is exactly similar for piston engine and turbine, so that the former derives no theoretical advantage from its constant mass type of compression. Practically, it achieves what is impossible in a separate adiabatic type of compressor, viz., a compression ratio of 40 to 1 with a high final temperature which, by virtue of the fluctuations in

intensity, does not affect the cylinder walls to the prohibitive extent that would exist in the separate compressor. The fact of this high compression gives the piston engine its present unique position, but the writer hopes to enunciate means with which a 40 to 1 ratio may be exceeded, and ultimately the internal combustion turbine may surpass the piston engine in overall efficiency. A combination of super and sub-atmospheric working offers the most encouraging hopes, but the cycles will be strictly within the fundamental laws. The superior thermal efficiency will offset the low mechanical efficiency of the turbine. At present, we cannot hope for efficiencies over 30 per cent., mainly on account of the compression ratio limitation.

A statement is also made upon the possibility of increasing gas flow velocity by the simple addition of heat without any concurrent variation in pressure. This assumption does not appear to be justifiable by facts. In the expression

$$dQ = C_v\,dT + A \cdot p \cdot dv + \frac{A \cdot W \cdot dw}{g} \quad . \quad . \quad (1)$$

it must be borne in mind, if the gas flow is freely expansive, that $A \cdot p \cdot dv$ and $\frac{A \cdot W \cdot dw}{g}$ are not separable functions; they really form portions of a single expression of energy, such that, say—

$$dS = A\,p \cdot dv + \frac{A \cdot W\,dw}{g}$$

and

$$dQ = C_v \cdot dT + dS \quad . \quad . \quad . \quad . \quad (2)$$

An application of the first law of motion to a flow channel, the area of which changes from a to $a + da$ while the pressure falls from p to $p - dp$, and the velocity rises from W to dw, gives, by equating the rate of change of momentum to the pressures causing the change—

$$g \cdot a \cdot dp = dw \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and should dp vanish, then dw becomes zero. It is assumed, of course, that no artificial restriction is placed upon free expansion. The expression (3) leads to $g \cdot V \cdot dp = \frac{W \cdot dw}{g}$, and thence by integration, to the well-known equation for nozzle flow. What I wish to make clear is that expression (1) cannot be interpreted apart from the momental law; there can be no change of velocity without change of pressure. The reversed sequence of operations; the cooling of rapidly moving gases at constant pressure without any variation in velocity may have an important position in the future turbine with special exhaust gas treatment.

The real obstacles in the way of progress are (1) the difficulty of securing a high compression ratio; and (2) the high ratio of negative to positive work given by existing means of compression. The reasonable solution of these two problems will place the gas turbine on a sure footing. In conclusion, may I reiterate that the development of the gas turbine is not being retarded owing to theoretical difficulties; they are negligible. What is wanted immediately is experimental work on known principles, but, unfortunately, that entails expenses of such magnitude, that the theoretical engineer who is desirous of translating theories into practice, is debarred from proceeding beyond the seclusion of the Patent Office.

Birmingham, December 15th. HENRY A. HEPBURN.

LAUNCHES AND TRIAL TRIPS.

MACRALPH, steam tug; built by James Pollock, Sons and Co., to the order of Griffith and Co., of East Greenwich; dimensions, 65ft. by 15ft. 3in. by 6ft. 9in.; to carry about 10 tons. Engines, surface condensing, 13½in., and 26in. diameter by 18in. stroke; constructed by A. G. Mumford and Co., Limited, Colchester; trial trip, recently.

PORT BRISBANE, twin-screw steamer; built by Workman, Clark and Co., Limited, to the order of the Commonwealth and Dominion Line, Limited; dimensions, 500ft. by 62ft. by 44ft. 3in.; 9000 gross tonnage. Engines, two sets of triple-expansion; constructed by the builders; trial trip, December 4th.

KNARESBRO, steamer; built by W. Gray and Co., Limited, to the order of the Ellerman Lines, Limited; dimensions, 465ft. by 57ft. 9in. by 34ft. 8in.; 11,300 tons deadweight. Engines, triple-expansion, 26in., 45in., 78in. diameter by 54in. stroke, pressure 230 lb.; constructed by the builders; trial trip, December 6th.

LOCHMONAR, twin-screw motor vessel; built by Harland and Wolff, Limited, to the order of the Royal Mail Steam Packet Meat Transports, Limited; dimensions, 485ft. by 62ft. by 39ft. 6in.; 9500 gross tonnage. Engines, two sets of Diesel, Burmeister and Wain type; constructed by the builders; launch, December 8th.

WELLFIELD, twin-screw motor vessel; built by the Tyne Iron Shipbuilding Company, Limited, to the order of Hunting and Son, of Newcastle-on-Tyne; dimensions, 385ft. by 51ft. 3in. by 30ft. 6in.; 7900 tons deadweight. Engines, twin-screw four-stroke cycle Diesel; constructed by the North-Eastern Marine Engineering Company, Limited; launch, December 8th.

ROYAL INSTITUTION.—The course of Christmas lectures adapted to a juvenile auditory will be entitled "Concerning the Nature of Things" and will be delivered by Sir William Bragg, K.B.E., F.R.S., who, it will be remembered, has succeeded Sir James Dewar as Fullerian Professor of Chemistry. The syllabus of the course is as follows:—(I.) The Atoms of which Things are Made; (II.) The Nature of Gases; (III.) The Nature of Liquids; (IV.) The Nature of Crystals: Diamond; (V.) The Nature of Crystals: Ice and Snow; (VI.) The Nature of Crystals: Metals. The lectures will be delivered on Thursday, December 27th; Saturday, December 29th; Tuesday, January 1st; Thursday, January 3rd; Saturday, January 5th; and Tuesday, January 8th. Subscription one guinea; juveniles (age ten to sixteen), half a guinea. Lecture hour, three o'clock.

INSTITUTION OF MECHANICAL ENGINEERS.—The annual dinner of the Institution of Mechanical Engineers was held on Thursday, the 13th inst., at the Connaught Rooms, Sir John Dewrance, the President, taking the chair. The toast of "The Houses of Parliament," which was proposed by Sir Henry Fowler, evoked from Lord Montagu of Beaulieu a defence of the House of Lords. The Upper House was, he said, all the more necessary, the more powerful the House of Commons became. Brig.-General J. S. Nicholson also responded. Sir L. Amherst Selby-Bigge, in proposing the "Institution of Mechanical Engineers," referred to the rapid growth of the society within recent years, and the President, in responding, mentioned the bequests by Mr. W. H. Allen and Professor Coker. In connection with the George Stephenson Fund, started by Professor Coker, Sir John referred to the coincidence that his father helped to erect the Rocket. The toast of "The Visitors" was proposed by Mr. W. H. Patchell, President-designate, and was responded to by Rear-Admiral C. T. M. Fuller and Sir Charles Langbridge Morgan.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

The Market Position.

WITH Christmas only a few days ahead, business on the Birmingham Iron and Steel Exchange to-day—Thursday—was not so brisk. There was a marked falling off in inquiries, and few orders of any size were placed, but values remained very firm. Both producers and consumers are now turning their attention to the first quarter of the year 1924, when they hope for greater activity. Development schemes are expected to make more impression on the demand for iron and steel than they have done as yet. In the meantime, iron and steel manufacturers and merchants are preparing for stocktaking and clearing up their books. Most of the works in this district will have a full week's holiday.

Dearer Steel.

The steel works are very well off for specifications and are in no difficulty in regard to the disposal of their output for some time. This strong position, coupled with the efforts to revive price control associations, is having a hardening effect upon steel values generally. The better demand for ship plates has enabled the makers through their association to put up prices 10s. per ton, making the selling figure £10 10s. Boiler plates have risen by a similar amount to £14. It is understood that a few firms remaining outside the Association will conform to these standards. In the case of small steel bars, £10 15s. for large business and £11 for small lots are the ruling prices. Structural steel has also become dearer during the week. Angles and joists are now quoted £10, but so far as prices are regulated, they follow a graduated scale according to tonnage. Irregularities are still apparent, however, and prices well below the £10 level are heard of. While a lull has followed the late activity, prospects are held to be good. Billet values are slightly less firm, and here and there one hears of orders having been accepted at £8 10s., though the general level remains £8 15s. The Belgians, who were lately prepared to take on any quantity of steel orders, are now largely off the market, having booked as much business as they can handle. It is still possible, however, to buy billets at £7 12s. 6d. Merchants and re-rollers are frankly gratified that they are able to take advantage of the cheapest material available, whether of British or foreign origin. Fewer orders have this week been given out to continental firms from this district than was the case last week.

Steel Scrap.

The rise in steel scrap prices has lost a little of its impetus, £5 apparently being the top figure, with £4 15s. as a minimum. It is considered doubtful whether this price will be maintained. But there is not much of this material on offer.

Finished Iron.

The Staffordshire finished iron mills have a fair amount of business on their books to carry them into the New Year. The new rolling stock orders will increase the activity of the Staffordshire iron trade, and it is known that some more orders of the same kind are pending and are likely to be placed early in the New Year. Makers of marked bars find a fairly good outlet for best bars at £14 10s. Prices of Crown bars are gradually moving up, and as a rule Staffordshire makers ask £12 10s., with slightly lower prices for other descriptions of merchant iron. Lancashire makers cultivating the Midland market are firm in their quotation of £12 10s. For nut and bolt bars they quote up to £11 10s., but find little business coming their way, and Staffordshire makers for the most part quote £11. A few are endeavouring to get half-a-crown to 5s. more. Demand from the nut and bolt industry is now fairly satisfactory, and gives promise of improvement. It is still possible to buy Belgian No. 3 iron for nut and bolt making at £8 17s. 6d. delivered in the district, but it is of inferior quality. Prices of iron scrap have increased considerably. Some of this costs as much as £6 per ton, and the large recent increase is a matter of some importance to Staffordshire ironmasters.

Galvanised Sheets.

Although the galvanised sheet trade has quietened a little, as is not unusual towards the end of the year, producers continue in a strong position, and report further promising inquiries from overseas markets. Values have an easier tendency. Most of the mills want £19 for 24 gauge corrugateds, but some of them are ready to entertain offers at £18 15s.

Pig Iron.

The Midland pig iron position remains steady, the orders now absorbing the output without the necessity of relighting furnaces. Profits are still cut very fine, and the tendency of coke prices to harden discourages enterprise. Derbyshire furnaces have now made good the quotation of £4 15s. for No. 3 foundry iron. Nothing could be heard of under that price on 'Change to-day. Efforts to improve upon it, however, were unsuccessful. Derbyshire forge is firm at £4 9s. to £4 10s. North Staffordshire foundry iron is in good request at £4 15s. upwards, while forge of this make commands £4 10s. Northamptonshire foundry pig is quoted £4 13s. 6d. upwards, and forge £4 7s. 6d. There is a strong demand for basic pig.

Increasing Coke Values.

Blast-furnace owners in the Midlands are becoming anxious regarding their coke supplies, for there is again a threat of a shortage. Continental buyers are again pressing for supplies, and have during the last two weeks placed considerable orders. There is also a larger consumption at home, as the demand for iron and steel expands. Hence it is increasingly difficult to get supplies. Iron and steel masters this week complain that there is little furnace coke to be had at 24s. per ton at ovens, the price which it was understood was to rule until the end of March. Quotations for good grade coke have gone up to 25s. and 26s., and even higher prices are mentioned. Foundry coke is also becoming difficult to obtain.

Foundries Busier.

Foundries in South Staffordshire have become busier, especially in the case of makers of machine parts, who are being pressed for supplies in connection with repairs and replacements usually called for at the end of the year.

Unemployment.

The number of persons without work in the Midlands area now stands at 149,522, or 1108 fewer than last week. There has been a fall in the Birmingham figures of 1463 during the week, the total now standing at 37,272. The Coventry returns show a decline of 465, the number having fallen from 4511 to 4046. Decreases have also taken place at Bilston, Cradley Heath, Dudley, Leicester, Longton, Northampton, Nottingham, Oldbury, Smethwick, Stourbridge and Brierley Hill, Walsall, West Bromwich, Worcester and Wolverhampton.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

THE effect of the near approach of the holidays and the stock-taking period is being more definitely felt in the Manchester market this week, and the amount of new business passing is only very moderate. Apparently there are a few consumers who have not bought all they think necessary, and consequently some inquiries are about; but the bulk of inquiry now is for delivery next year, and it is noticeable that sellers are not very anxious to meet it. This suggests that in the majority of cases sellers of iron and steel, if not of the non-ferrous metals, expect a slightly higher level of prices early in January, and are desirous of retaining a free hand for the early months of the New Year. It is, of course, possible to find reasons why prices of iron and steel should not advance, but, on the whole, the probability seems to be in favour of a moderate improvement in selling prices. It may be hoped that in any case this will not be pushed too far, as in that case a "set-back" might occur with a very bad effect on general market feeling.

Metals.

The market for copper keeps very steady, and the fluctuations lately have been so slight as to be scarcely noticeable. In fact, for refined copper the same prices have been quoted for a long time. The situation at which the trade has arrived is peculiar, for while many people seem to have given up any expectation of a rise there would seem to be no margin for a fall. North American producers of copper are complaining that the industry is now being worked at a loss; and it is certainly amusing to find them clamouring for a protective duty on South American copper. No doubt the South has increased its output very largely, and is no longer a negligible factor so far as the North American Continent is concerned; but that the North—as by far the largest producer in the world—should seek protection is certainly strange. Buyers here, of course, have to consider whether a United States duty on South American copper, say, 5 cents per pound, as is proposed, would lead to the "dumping" of the balance of Northern copper available for export at lower prices, while the American consumer was made to pay the extra 5 cents per pound. Such a development might make refined copper cheaper on this side, at any rate for a time. It would, however, be rash to assume that American copper producers will obtain the protective duty for which they are asking; but if they do it can scarcely be other than advantageous for the copper consumer here. Prices for manufactured material remain unchanged at £95 per ton for strong sheets and £105 for flat bottoms. Brass condenser tubes are at 1s. 2½d. per pound and brass locomotive tubes at 1s. Yellow metal rods are 7d. per pound. The market for the scrap non-ferrous metals remains very dull, and the prices paid by dealers here—except for lead—are very far below the intrinsic value. Dealers offer £46 to £47 per ton for scrap gun-metal, £37 to £38 for heavy yellow brass scrap, and £51 per ton for "brasiary" copper. The market for tin is steady again, and the recent set-back has been recovered. At the moment there seems to be no scarcity of the metal, and possibly prices will keep steadier over the holidays; but the underlying conditions of the market are thought to be good; and there are still many people sanguine enough to foretell £250 per ton. The rate of consumption is still greater than that of production, so that the reserves are being reduced. Both lead and spelter have been very steady markets for some time now; but lead is the more sensitive. This, of course, is natural because while spelter is at quite a moderate price, lead is very much dearer than it used to be.

Pig Iron.

The markets here for pig iron are quieter than they were, and very little new business is being done this week. Probably a good deal could even now be done just before the holidays, if sellers here were willing to make contracts for the first six months of 1924 at a basis of 95s. on trucks for Derbyshire iron; but they have got it firmly into their heads that another 5s. per ton will be obtainable next year, and consumers are not willing to contract at such an advance. Much will depend upon whether or not some of the idle furnaces in the Midlands are lit up early next year. There seems a probability that the North Lincolnshire furnaces will soon be re-started, and certainly if contracts over six months could be made at 100s. on trucks, there would be every chance of this

increase in the supply of pig suitable for the Manchester market. There are still one or two sellers of Derbyshire iron who will accept 95s., or, say, 103s. delivered here for immediate delivery; but there are others who hold out for 96s. and 96s. 6d. on trucks even for prompt delivery, and sales have been made at these higher figures. Forge pig iron is firmer, and the demand seems to be improving; but the demand here for Scotch pig is not large, although the price is firmly held at 125s. per ton delivered. East Coast hematite pig can be bought in Manchester at some 7s. 6d. per ton less than the Scottish price.

Steel.

There is very little news in the market for finished steel. Some large contracts from the railways have been reported; but these are for rails and wagons, and may not affect Manchester except indirectly. The official prices for steel joists and angles are still £10 per ton in Lancashire, and £10 5s. in Cheshire. Business is inclined to fall off as the year closes, but this is not taken as meaning anything to the detriment of the market prospects.

Scrap.

The markets here for scrap are steady, and there is no weakening in the feeling. On the contrary, dealers seem to be stiffer, especially in the matter of foundry scrap. One cannot say that there is much buying at the moment, but strong dealers are holding out for 95s. per ton for the best classes of cast scrap iron. Consumers of heavy wrought scrap are offering 95s. delivered at the ironworks; but there is less demand at the moment for heavy steel scrap. Buyers, both in Sheffield and in Wales, are holding off for a time; but dealers are fairly confident that they must come in again early in the New Year; and that then prices will revive again. After all, steel scrap is still the cheapest material available for them.

Manchester Association of Engineers.

A paper, entitled "Power Shovels and Draglines," was read at a meeting of the Manchester Association of Engineers on Friday, the 14th inst., by Mr. W. Barnes, M.I. Mech. E. The author said that there was still an idea abroad that the use of excavating machinery meant throwing men out of employment. Sometimes it did so for short periods, but in practically all cases it meant a larger output and diverted the displaced labour on to other and more congenial work. Many times, he said, the introduction of an excavator had made all the difference between a loss and a profit. Another economical reason for the introduction of excavating machinery mentioned by Mr. Barnes was the time saved in big undertakings, such as irrigation and drainage schemes which could be brought into use sooner than if hand labour was employed. He added that the use of excavating machines for clay had more than quadrupled during the last few years; approximately 95 per cent. of the raw material for the manufacture of cement in this country and 90 per cent. of the world's iron ore were being obtained with them. The paper was admirably illustrated by means of cinematograph apparatus.

William Thomas Stubbs.

It is with much regret that I have to announce the tragically sudden death at Bournemouth on Thursday, the 13th inst., of Mr. W. T. Stubbs at the age of sixty-six. Mr. Stubbs was chairman of the two Manchester firms—Joseph Stubbs, Limited, and Electromotors, Limited. During his life-time he took an active part in public affairs, having been President of the Manchester Chamber of Commerce for three years and the Manchester Engineering Employers' Federation. The latter post he held for two years. He was the eldest of six sons of the late Mr. Joseph Stubbs, textile machine maker, who originally took over the old firm of Joseph Hetherington. The firm to-day stands in a very prominent position in connection with the manufacture of machinery for yarn doubling for the production of sewing cotton and cotton for the lace trade. Starting with a mere handful of employees, the two works with which he was connected now employ from 900 to 1000 workpeople. He was a member of the Manchester Association of Engineers and a life member of the Engineers' Club, Manchester.

BARROW-IN-FURNESS, Thursday.

Hematite.

The hematite pig iron trade is looking healthier every day. The improvement is slow, but that in itself is not a bad sign. On the last occasion when a spurt occurred, when the French entered the Ruhr, the demand became heavy only to fizzle out, leaving the market worse than ever. There is more confidence, and as the steel plants are getting busier and consequently taking more iron, there is every reason to expect an increase in the number of furnaces. The present output is not great, but there are signs, both at home and abroad, of a bigger demand. The shipbuilding and engineering trades in this country are becoming busier, and as their activity increases so will the demand for mixed Bessemer numbers increase. The prices remain firm and, if anything, have an upward tendency. For some time the continental trade has been dull, but in this side of business there appears to be a chance of improvement. There is not much business with America at the moment, and although hopes have been expressed for some time that American trade would increase it has not come to pass as yet.

Iron Ore.

The iron ore trade remains only moderately active, and until there is an increase in the number of furnaces there is not much chance of an improvement. There is not a great amount of ore going out of the district at present, but the amount may increase as the iron trade expands generally. As regards foreign ore the position is about the same. The demand is not heavy, and the importations are not likely to improve to any great extent until business has considerably expanded in the iron market.

Steel.

The position in the steel trade is fairly good. The Barrow rail mills have work for some time yet, and the Workington rail mills are engaged most of the month, with occasional breaks. Foundries have a moderate amount of business. The hoop and section mills are fairly well employed and likely to be.

Shipbuilding and Engineering.

There is no doubt that the settlement of the boilermakers' dispute has improved the outlook very considerably. There are no fresh orders for ships to be reported at the moment, but it will not be long before there is better news for the district, inasmuch as there is a tendency on the part of shipowners to place orders now that labour is more settled. Messrs. Vickers have received an order for 70 locomotive boilers for the London, Midland and Scottish Railway, and they have also secured orders for a portable combined crushing, screening, elevating and loading plant for Limerick, three steel frame jaw crushers, screens and motors for India—Public Works Department—in connection with the Sutlej Valley project, and also a special gearless gyratory type of breaker for producing chippings. The latter is for Australia.

LATER.

Vickers Limited announce that they have been instructed by the London, Midland and Scottish Railway Company to build at Barrow two cargo boats for the Goole and continental service. These steamers will be fitted specially for carrying cattle and horses, and will be 240ft. long, 35ft. beam and 16ft. 4in. depth. The speed will be 13 knots. Vickers have also secured the contract for the repairing and reconditioning of the steamer Casserea for the Isle of Man Steam Packet Company. She was formerly owned by the Southern Railway Company, and was on the Channel Islands service. She is a triple-screw steamer, and will be placed on the Isle of Man service next year.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Trade Progress.

THE improvement in the basic steel trade of Sheffield and district, noted during the last few weeks, is well maintained. The approach of the Christmas holidays has caused something of a falling off in orders and inquiries, but this is looked upon as merely seasonal and temporary, and the general tone is good. The district's equipment for the production of basic steel has advanced by leaps and bounds during the past few years; in fact, the industry may be said to have grown up since the war, and it has proved remarkably successful since trade began to mend about twelve months ago. During October the average production was at the rate of about 12,000 tons per week. Allowing for the fact that certain furnaces must be stopped periodically for repairs, the United Steels group is now working almost up to capacity. At the Templeborough works, eight of the fourteen furnaces, each of 60 tons capacity, are running full time, and good reports come from Samuel Fox and Co.'s and the Parkgate Works. The demand for acid steel, which not very long ago was Sheffield's speciality on the heavy side, has not improved to the same extent, the production in October having been about 38,000 tons. This department is expected to benefit greatly when the orders for railway material come along.

Railway Companies' Requirements.

Up to the present, the bulk of work in axles, tires and springs has not been placed, although there has been a regular stream of orders sufficient to keep the plants comfortably employed. For rails, however, some large contracts were placed by the London, Midland and Scottish Railway last week-end. Steel, Peech and Tozer, the parent firm of the United Steels group, booked 20,000 tons, and Samuel Fox and Co. 10,000. The Parkgate Iron and Steel Company is sharing in some of the work, and, in addition to orders received direct, it is to supply a considerable quantity of constructional material required by other firms. It is announced that this company proposes to put a second blast-furnace in operation very early in the New Year. The London, Midland and Scottish Company has also ordered 250 mineral wagons from Clayton Wagons, Limited, of Lincoln, and 100 12-ton mineral wagons (wood frames) from Harrison and Camm, of Rotherham.

Work for Doncaster and Derby.

The carrying out of the London and North-Eastern Railway Company's programme will greatly benefit Doncaster, where the company has large works. Recently, an order for 30 "Pacific" engines, to cost £300,000, was placed with the works, and now it is announced that they are to build 20 more locomotives of the same type, as well as 12 passenger tank engines, 1000 12-ton open goods, 250 10-ton covered fish, and 500 12-ton covered goods wagons. In the course of the next year the company will build some 150 locomotives at a cost of £800,000, and at Doncaster it is expected that the output will have to be doubled and a new machine shop erected. The great shops of the London, Midland and Scottish Railway at Derby are also looking forward to busy times next year. Mr. Arthur Watson, the general manager of the company, has stated that 40 heavy passenger engines, more powerful than have ever been built at Derby, will be constructed there during the next twelve months. Further, 7000 wagons and 200 main-line coaches are to be built, as compared with the previous highest total of 4500 wagons and 100 coaches. The Derby works are fairly busy at present, and when they are fully going on the work referred to they will employ 10,000 men.

Still More Orders.

Vickers Limited have just booked several orders for crushing machinery. The Limerick County Council has accepted the company's tender for the supply of a portable combined crushing, screening, elevating and loading plant for use in road schemes. The Public Works Department of the Government of India has given the company an order for three steel-frame jaw crushers, screens and motors for use in connection with the Sutlej Valley project; and the firm is also to make for Australia a special gearless gyratory type of breaker for producing chippings. At the Barrow works, Messrs. Vickers have received an important contract from the London, Midland and Scottish Railway Company for the construction of seventy locomotive boilers. This substantial order will provide employment for a large number of men in the boiler shops, which have been very slack for a long time, although, since the end of the boilermakers' dispute, many more men have been employed, and more are being taken on almost daily.

Light Steel and Tools.

While the heavy trade shows a great improvement as compared with a year ago, and the rolling mills, sheet mills and heavy forging sections are much better employed, the same amount of progress is not recorded on the lighter side. There are very few electric furnaces at work on the making of special steels. The crucible steel side continues to improve, though slowly. The manufacture of hacksaws is a good line. The file trade has suffered greatly from the depression, but it has recently shown signs of considerable recovery, although the present output is not much more than half the capacity of the plant. From a profit-making point of view, the file makers have had one of the most unsatisfactory of years. The quietude of general engineering has greatly interfered with the home demand for their products, while in the export markets very severe American competition has had to be faced.

Cutlery and Plate.

Although some firms have received numerous late requests from retailers for small quantities of goods urgently required for the Christmas trade, the special seasonal demand has, in the main, come to an end, and there has been a considerable falling off in the number of orders. Table knives of stainless steel continue in good demand, and the work which has been placed with Sheffield for table furnishings for the British Empire Exhibition will provide welcome employment for a substantial time. The year on the whole has been a very thin one for cutlery manufacturers, especially for the old-established houses, few of whom have earned any profit, while some have actually worked at a loss. The buying has been of a keenness never before experienced. The value of cutlery exported during November was £88,000, a fall of £30,000 as compared with October. The latter, however, was the best month experienced for a long period, and included the Christmas trade with distant parts of the Empire.

Sheffield Smoke Criticised.

Professor H. E. Armstrong, F.R.S., who lectured on low-temperature carbonisation last week, at a meeting of the Yorkshire Association of the Institution of Civil Engineers held in Sheffield, vigorously attacked Sheffield on the smoke question. He said that Sheffield was a stark, staring example of the improper use of coal—of waste which had been little short of criminal. Its future, its very existence, depended upon its learning to use coal economically. Smoke could be abolished if Sheffield developed a proper method of using fuel by bringing intelligence to bear, and that intelligence would tell in every direction. He went on to urge that the production of a solid smokeless fuel, with its attendant consequences, was of such enormous national importance that it could not be left much longer in the hands of individuals. It was the duty of the nation to see it through without delay. He would hate, however, to see the work lapse into Government control. What they had to do was to make smokeless fuel on a large and economic scale. He was persuaded that this could be done by a little rational effort, but not by tinkering, private or public.

NORTH OF ENGLAND.

(From our own Correspondent.)

Cleveland Iron Trade.

ENCOURAGING accounts continue to be given of the Cleveland pig iron trade. The near approach of the holidays has, of course, tended to restrict business, but transactions this week have been on a heavier scale than is generally experienced at this particular period of the year. In fact, the market has developed a strong undertone, and many consumers have been buying well forward, being apprehensive of a rise in prices as soon as the turn of the year is reached. Production is well taken up and stocks are at a low ebb. Competition, especially by France, is still felt, but this may be of short duration, as the export bounty on French iron is expected to be discontinued early next year. Prices are firmly maintained, No. 1 being 100s. 6d.; No. 3 G.M.B., 100s.; No. 4 foundry, 97s. 6d.; and No. 4 forge, 96s. 6d. per ton.

Hematite Pig Iron.

The demand for East Coast hematite pig iron continues on a very heavy scale, due to the increasing activity at the steel works. Some very large orders have recently been placed on home account, but foreign business as yet shows little signs of expansion. Makers are still prepared to accept 102s. 6d. for mixed numbers for December delivery, but are quoting 103s. 6d. for January. No. 1 hematite is at a premium of 1s. per ton.

Iron-making Materials.

There is still a little activity in the foreign ore trade, and it is thought that prices may move up again. In the Ruhr work is being resumed, and it is expected that Germany may be a big buyer of foreign ore, in which case

higher prices are not improbable. Meanwhile, however, sellers firmly adhere to 25s. per ton o.i.f. as their price for best Rubio ore. There seems to be a good deal more coke about just now, and good medium furnace kinds are now on offer at 38s. per ton delivered at the works, but even that figure does not attract buyers.

Manufactured Iron and Steel.

A progressive improvement is reported in the manufactured iron and steel trade. There is a good deal more activity now at the shipyards, and this, of course, means that more steel is required. Heavy orders for railway material have also been placed, and local steel manufacturers are now well placed. Nevertheless, it is expected that there will be a full week's holiday at the majority of the steel works next week, when necessary repairs will be executed. Prices are firmly maintained.

The Coal Trade.

There is no material alteration in the Northern coal trade position, though the volume of business actually transacted just now is very limited. Most of the collieries are very fully contracted over the rest of the year and into next, so that nearly all the trade passing is between merchants for completion purposes and in order to clear up for the end of the year. There are said to be some fairly heavy inquiries in hand for foreign buyers, but under the present fluctuating conditions there is no disposition to buy. The inclination most observable is to await developments in the New Year, in the hope of being able to cover at lower prices than the collieries are at present willing to discuss. Forward business at the moment is in abeyance, and though there have been preliminary feelers put about, the results so far have been negligible in view of the high prices. The Durham market continues to give evidences of further acceleration in prices. As much as 27s. 6d. per ton has been done for best coking, and up to 28s. per ton f.o.b. has also been reported for best coking unscreened for this month's shipment. Gas coals are steady for best and special brands, while for secondary sorts the market is firm. The bunker market is steady and inclined to move forward. The position in the Northumberland market is not so secure. In fact, values of steam coals show a marked weakening tendency, and though there are hopeful signs for the beginning of next year, the present conditions are a little discouraging. Fairly large quantities of steams are being unloaded on the market, and as only odd lots can be readily absorbed, there remains a fairly large surplus for disposal at discounted prices. The coke trade is moderately steady, and prices are unchanged.

The Shipbuilding Slump.

Some idea of the depression in the shipbuilding industry on the Wear during the past year may be gauged from the annual returns which are now to hand. The gross tonnage launched was only 56,522, while in 1922 it was 130,961, and in 1920 333,335. The number of vessels launched this year has been 17 only, and five of the fifteen yards did not launch a ship. W. Gray and Company, of the Wear Shipyard, head the list with 16,548 tons, and it is understood that this firm has orders which will carry it well into next year. J. Priestman and Company are next on the list with 11,509 tons, while Doxford and Sons, Limited, have a record of 6290 tons only. The output of the Tyne shipyards during the year has also been very low. The Palmer Company launched eight vessels and the Northumberland Shipbuilding Company, Howden, and Hawthorn, Leslie, and Company, Hebburn, only two each.

Big Repair Order Goes Abroad.

The contract for the work of carrying out extensive repairs to the steamer, Richard Welford, has gone abroad. The vessel capsized at her moorings at Newcastle quay some time ago and was afterwards salved. Tenders were invited for the necessary repairs to the vessel and several Tyneside firms were among those who sent in prices. The contract, however, has been secured by a Rotterdam firm, whose figure is stated to be about £3000 less than the lowest British tender. The contract price is believed to be in the neighbourhood of £12,000.

SCOTLAND.

(From our own Correspondent.)

Firmer Markets.

PRICES of steel and iron are advancing, and coal continues to show an upward tendency. In the case of the first two, higher oncosts are partly responsible, while in the case of the last-named a scarcity of prompt fuel is the cause.

New Contracts.

Steel works in the Clyde area are participating in the London, Midland and Scottish Railway's contract for steel rails, and wagon builders in the district will also benefit from the contracts for mineral wagons. Alex. Hall and Co., shipbuilders, Aberdeen, have received an order for the construction of a 12,000-ton steamer from Messrs. Cook and Sons, shipowners. This vessel is to be ready by next June, and is to be utilised in the regular trade between Baltic, East Norwegian and East of Scotland ports.

A Record Casting.

Messrs. Miller and Co., engineers and ironfounders, London-road Works, Edinburgh, have just cast a huge chilled steel calender roll, weighing 30 tons, having a length of 25ft. and a diameter of 3ft. This roll is to form part of the biggest paper-making machine in the world.

Supporting Home Industries.

The recommendation from the Tramways Committee to accept the American offer for steel rails for special track work was disposed of at the last meeting of the Glasgow Corporation. Three offers from British firms were also under review, and after some discussion it was decided, on a vote, to give the contract to Hadfields, Limited, the British firm which submitted the lowest tender next to the American offer, which was the lowest of all. Unemployment in this country was really the deciding factor.

Pig Iron.

Apparently the steady advance in prices is not restricting business in pig iron so far. At any rate, the home demand continues to expand, especially for forward delivery. The output is not too large, and consumers are anticipating requirements. Export demands are rather slow, however, and an increase in this department would necessitate a larger production.

Steel.

Higher costs of pig iron and scrap materials have caused a rise in steel prices, and since last week the quotation for boiler plates has been brought into line with other steel products and advanced by 10s. per ton to £13 10s. per ton delivered Glasgow. In most instances the output is still below capacity, but a considerable improvement is noticeable. In plates and sections more orders are on hand, and a larger production is practically certain when the shipbuilding yards are in full swing again. Steel sheet makers still report a fair degree of activity. Home and export demands for both light and heavy sheets are comparatively well maintained. Galvanised sheets, too, are well booked for shipment.

Bar Iron.

Specifications for bar iron for home delivery are increasing, orders from shipbuilders, railways and wagon builders being prominent. The home prices are 10s. per ton dearer at £12 10s. per ton basis for Crown bars for Glasgow delivery. In this trade also, however, a larger export turnover would be welcome. Re-rolled steel is sharing in the increased business.

Coal.

Apart from a further firming tendency in prices, there is nothing of fresh interest in the coal trade. In all districts the majority of the collieries are fully booked up for round fuel until the end of the year at least, and supplies for prompt delivery can scarcely be secured unless through second-hands at higher than colliery rates. A fair number of inquiries for January shipment are in circulation, but owners are evidently not too anxious to commit themselves at present. Washed nuts have a steady turnover at current prices. Shipments are heavier. Despatches from the West of Scotland and the Lothian ports are fairly prompt, but delays are still experienced at Fifeshire ports, where a considerable number of steamers await cargoes. Aggregate shipments for the week amounted to 308,141 tons, against 292,346 tons in the preceding week and 286,696 tons in the same week last year. Home demands continue to increase. Gas and electricity works are taking heavy deliveries, and industrial sorts are busier. Household fuel is in heavy demand, despite the higher prices, which mean a fairly common charge of 2s. 4d. per cwt. bag for best qualities.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

THE loading pressure at all South Wales ports this week has been on an abnormal scale, and it is certain that many steamers which arrived up last week-end and since then will have to wait until after the Christmas holidays to secure their cargoes. The operation of the third shift is only partial, and while on this scale it is, of course, beneficial, at the same time it is insufficient to cope with the situation. Last week there were over 70 steamers awaiting berths, and on Monday last there were as many as 85 steamers waiting their turn to load. Unfortunately, many steamers have been on demurrage even before they have commenced to load, so that some of the firms will have to face some very heavy demurrage accounts. It has now been definitely arranged that the coal trimmers and tippers at South Wales ports shall knock off work on Monday next at 5 p.m. and will not resume until 6 a.m. on Friday morning, so that it will be seen that next week as a working week will be a very poor one. As previously pointed out, the miners will take the first three days of the week off as their vacation. The fact that there will be so much tonnage to be dealt with after the holidays, combined with the scarcity of coals as the result of the holidays, means that firm conditions may be looked for during the first half of January at least. At the same time, however, it is expected that the second half of January will see a falling away in values for the reason that consumers abroad are not buying on the basis of the prices which have been recently ruling. Foreign buyers are holding off in the belief that the high prices of late will not be maintained. Furthermore, there is a certain amount of anxiety existing consequent upon the orders which are being placed for American coals. It is reported that the Americans have just arranged for a further 100,000 tons to be sent to Europe in the early part of 1924, all of which means that less coal will be required from this district. It is not improbable also that the fear of trouble in this country between the miners and the employers on the wages agreement question will operate adversely. It may be argued that this is anticipating trouble, but the fact remains that uncertainty as to what may happen is always very damaging to trade.

New Ships.

If only the miners' wages question were out of the way it is safe to say that the views in coal trade circles are moderately optimistic regarding next year. Certainly it is the case that the opinion prevails that now is the time to buy rather than to sell tonnage. Quite a number of steamers have recently changed hands. The Tree Steamship Company, Limited, which in 1919 sold six steamers to the Maindy Shipping Company, Limited, for the sum of £450,000 and then voluntarily wound up, has recently been again registered, and the managers, Messrs Howard-Jones, have placed orders for two new cargo steamers to be named the Ashtree and Beechtree. These steamers are to be 2300 tons deadweight. One will be built by Craig, Taylor and Co., Limited, of Stockton-on-Tees, and engined by the North-Eastern Marine Engineering Company, Limited, of Sunderland, and the other will be constructed by Robert Thompson and Sons, Limited, of Sunderland, and engined by George Clarke, Limited, of Sunderland. Delivery of the steamers is to take place next May or June. Messrs. Stone and Rolfe, of Llanelly, managers of the S. and R. Steamships, Limited, have placed an order with the Hansen Shipbuilding and Ship-repairing Company, Limited, of New Quay-yard, Appledore, for a cargo steamer of the raised quarter-deck type of about 1650 tons deadweight, for delivery in May next. This steamer will be engined by Macoll and Pollock, Limited, of Wreath Engineering Works, Sunderland, with triple-expansion engines of 800 indicated horse-power.

Mid-Rhondda Men's Stay-in Strike.

All last week the miners at the Cambrian Group of collieries adopted a stay-in strike on account of the dispute with the management, it being alleged that the management had dismissed a large number of men, that standing customs had been terminated, and that the payment of the minimum wage to certain men had been refused. By adopting the stay-in strike the miners declined to work overtime or to do any work outside their own particular grade. The matter, however, came before the Coalfield Disputes Committee, who referred the dispute back to the management and workmen's representatives, and as the result of various meetings and negotiations and the assurances by the management mass meetings of the men decided to call off the stay-in strike. Arrangements were made for dealing with all cases in dispute, and according to the official report from the men's side the management is to be given an opportunity to demonstrate to the workmen that it is prepared to treat them fairly.

Current Business.

The steam coal market continues to be firm, but the amount of business passing is negligible for the reason that the majority of exporters have now made their arrangements for coals for loading immediately before and after the holidays and, furthermore, the collieries are so heavily committed that they have no coals to spare. Here and there small parcels are changing hands for the purpose of finishing off cargoes, but this business is for the most part done through middlemen who happen to hold coals on contract and are prepared to sell at slightly less than the collieries are quoting if the stem can be arranged, thus making sure of lifting their coals and taking their profit. It is unlikely that much, if any further business will be done until the New Year, when it is seen how the present accumulation of tonnage in dock is dealt with. Best Admiralty large is firmly quoted at 29s. 6d. to 30s. for anything like prompt shipment, but sellers are prepared to modify their indications for the second half of January. Smalls of the superior grades are still scarce, but not quite so difficult to obtain as was the case a week ago. Coke is a firm market, and best grades of foundry coke command 60s., at which price business has recently been arranged. There is no change of note in patent fuel, and anthracite coals remain about stationary, though, on the whole, a shade steadier all round. Duff coals especially are scarce.

CONTRACTS.

ED. BENNIS AND CO., Limited, have recently received orders for sprinkler and chain grate stokers and self-cleaning compressed air furnaces for varying numbers of boilers from twenty separate customers—half of them being repeat orders; and for coal and ash handling plant from nine separate customers.

THE LEA RECORDER COMPANY, Limited, of 28, Deansgate, Manchester, has recently received repeat orders for Lea coal meters for the Derby, Halifax, Grimsby, Wallasey, Bedford, Tunbridge Wells, the Charing Cross, West End and City, the South Metropolitan Electric Supply Company, and the Clyde Valley Electrical Power Company, Limited, electricity works, as well as orders from Australia, South Africa, China, and Japan.

THE Limerick County Council has accepted the tender of Vickers Limited, London, for the supply of a 16in. by 10in. portable combined crushing, screening, elevating, and loading plant for use in connection with its road schemes. Other orders received by this firm include three 24in. by 13in. steel-frame jaw crushers, screens and motors for the Public Works Department of the Government of India, in connection with the Sutlej Valley project, and also a Vickers special gearless gyratory type of breaker for producing chippings. The latter machine is for use in Australia.

SHIP REPAIRING AT SOUTHAMPTON.—We are informed that J. Samuel White and Co., Limited, of Cowes, Isle of Wight, have leased from the Southern Railway Company a portion of ground inside the Southampton Docks area, and adjoining the Prince of Wales Dry Docks, for the purpose of installing a plant for carrying out repairs. The contract for the erection of the necessary shops has been placed with the Glasgow Steel Roofing Company, Limited, and for the alteration to other buildings now on the site and preparing foundations, &c., with Mr. J. Croad, of Portsmouth. The works, when completed, will form, it is claimed, one of the most up-to-date repair establishments in Southampton, and will be capable of dealing with both hull and machinery repairs of all descriptions. It is anticipated that the buildings will be completed and the machinery installed by about the beginning of March. The department will be under the control of Mr. Hugh Morton, who was for many years repair manager with Barclay, Curle and Co., Limited, Glasgow, and while the works will be in themselves self-contained, they are within easy reach of the company's main works should at any time a repair of a special nature require the assistance of the shops or technical staff at Cowes.

Current Prices for Metals and Fuels

IRON ORE.

N.W. COAST—	
Native	19/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	25/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	5 8 9	—
No. 1 Foundry	5 11 3	—
No. 3 Foundry	5 6 3	—
N.E. COAST—		
Hematite Mixed Nos.	5 2 6	5 2 6
No. 1	5 3 6	5 3 6
Cleveland—		
No. 1	5 6 6	5 6 6
Silicious Iron	5 6 6	5 6 6
No. 3 G.M.B.	5 0 0	5 0 0
No. 4 Foundry	4 17 6	4 17 6
No. 4 Forge	4 16 6	4 16 6
Mottled	—	—
White	—	—
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	9 2 6	—
North Staffs. Forge	4 10 0	—
„ „ Foundry	4 15 0 to 5 0 0	
(3) Northampton—		
Foundry No. 3	4 13 6	—
„ Forge	4 7 6	—
(3) Derbyshire—		
No. 3 Foundry	4 15 0 to 4 16 6	—
Forge	4 9 0 to 4 10 0	
(3) Lincolnshire—		
No. 3 Foundry	4 15 6	—
No. 4 Forge	4 14 0	—
Basic	4 15 0	—
(4) N.W. COAST—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	5 15 0 (*a*) to 6 0 0 (*b*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	12 10 0	—
Best „	—	—
N.E. COAST—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
LANCS.—		
Crown Bars	12 10 0	—
Second Quality Bars	11 15 0	—
Hoops	15 0 0	14 15 0
S. YORKS.—		
Crown Bars	12 10 0	—
Best „	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	12 10 0	—
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	11 0 0	—
Gas Tube Strip	12 10 0 to 12 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	13 10 0	—
Ship Plates, ¾in. and up	10 5 0	—
Sections	10 0 0	—
Steel Sheets, 5/16in. to ½in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	19 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	10 5 0	—
Angles	10 0 0	—
Boiler Plates	13 0 0	—
Joists	10 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	13 0 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	9 5 0†	—
Light „	9 10 0 to 10 0 0†	
Billets	8 10 0 to 12 0 0†	
Hoops	14 10 0	—
MANCHESTER—		
Bars (Round)	10 10 0 to 10 15 0	
„ (others)	10 5 0 to 10 7 6	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	10 10 0	—
„ (Lancs. Boiler)	13 10 0	—
SHEFFIELD—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	9 0 0	—
Hoops	12 10 0 to 13 0 0	
Soft Wire Rods	11 10 0	—
MIDLANDS—		
Small Rolled Bars	10 15 0 to 11 0 0	
Billets and Sheet-bars	8 7 6 to 8 15 0	
Gas Tube Strip	10 15 0 to 11 0 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	18 15 0 to 19 0 0	
Angles	10 0 0	—
Joists	10 0 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	23/9 to 24/3
Block Tin (cash)	234 5 0
„ (three months)	236 5 0
Copper (cash)	62 7 6
„ (three months)	63 2 6
Spanish Lead (cash)	31 5 0
„ (three months)	31 7 6
Spelter (cash)	32 11 3
„ (three months)	32 16 3
MANCHESTER—	
Copper, Best Selected Ingots	66 10 0
„ Electrolytic	68 0 0
„ Strong Sheets	93 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 1 0
„ Condenser	0 1 2½
Lead, English	33 0 0
„ Foreign	31 10 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/9 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
„ 6 p.c. to 8 p.c. „	£22 0 0	8/-
„ 8 p.c. to 10 p.c. „	£21 0 0	8/-
„ Specially Refined		
„ Max. 2 p.c. carbon	£50 0 0	18/-
„ „ 1 p.c. „	£60 0 0	21/-
„ „ 0.75 p.c. carbon	£65 0 0	22/6
„ carbon free	1/6 per lb.	
Metallic Chromium	4/- per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£18 0 0 scale 6/- per unit	
„ Vanadium	20/- per lb.	
„ Molybdenum	9/- per lb.	
„ Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£130	
Cobalt	11/6 per lb.	
Aluminium (per ton)	£82 to £100	

(British Official.)

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	24/-
„ „ Ell	25/-
„ „ Splint	25/6 to 28/6
„ „ Trebles	25/-
„ „ Doubles	23/6
„ „ Singles	21/6
AYRSHIRE—	
(f.o.b. Ports)—Steam	24/-
„ „ Splint	25/6
„ „ Trebles	25/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	22/- to 23/9
Screened Navigation	28/-
Trebles	26/- to 27/-
Doubles	23/6
Singles	21/6
LOTHIANS—	
(f.o.b. Leith)—Best Steam	24/-
Secondary Steam	23/-
Trebles	25/3
Doubles	23/6
Singles	21/6

ENGLAND.

(8) N.W. COAST—	
Steams	29/-
Household	48/- to 59/-
Coke	43/6
NORTHUMBERLAND—	
Best Steams	24/3 to 25/6
Second Steams	21/6 to 23/-
Steam Smalls	14/6 to 16/-
Unscreened	20/6
Household	25/- to 28/-
DURHAM—	
Best Gas	24/- to 25/-
Second	23/- to 23/6
Household	25/- to 28/-
Foundry Coke	50/-

SHEFFIELD	Inland.	
Best Hand-picked Branch	33/- to 34/-	—
Barnsley Best Silkstone	27/6 to 29/-	—
Derbyshire Best Brights	27/- to 29/-	—
„ „ House	23/- to 24/-	—
„ „ Large Nuts	22/- to 23/6	—
„ „ Small „	17/6 to 19/6	—
Yorkshire Hards	22/- to 23/6	—
Derbyshire „	21/- to 22/6	—
Rough Slacks	12/6 to 13/6	—
Nutty „	10/- to 12/-	—
Smalls	5/- to 8/-	—
Blast-furnace Coke (Inland)	26/6 to 27/6	
„ „ (Export)	f.o.b. 32/- to 33/	

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	29/6 to 30/-
Second „ „	28/6 to 29/6
Best Dry Large	27/6 to 28/-
Ordinary Dry Large	26/- to 27/-
Best Black Vein Large	28/6 to 29/-
Western Valley „	27/6 to 28/6
Best Eastern Valley Large	27/6 to 28/6
Ordinary „ „	26/- to 27/-
Best Steam Smalls	21/- to 22/-
Ordinary „	18/- to 21/-
Washed Nuts	30/- to 31/-
No. 3 Rhondda Large	28/- to 29/-
„ „ Smalls	25/- to 26/-
No. 2 „ Large	25/- to 26/-
„ „ Through	20/- to 22/-
„ „ Smalls	19/- to 20/-
Coke (export)	55/- to 60/-
Patent Fuel	30/- to 32/6
Pitwood (ex ship)	29/- to 29/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	40/- to 45/-
Seconds	34/- to 36/-
Red Vein	32/- to 33/-
Machine-made Cobbles	52/6 to 55/-
Nuts	52/6 to 57/6
Beans	42/6 to 45/-
Peas	26/- to 27/-
Breaker Duff	13/9 to 13/-
Rubbly Culm	13/3 to 14/-
Steam Coals:	
Large	24/- to 25/-
Seconds	22/- to 23/-
Smalls	14/- to 16/-
Cargo Through	19/- to 21/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t., Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

† Latest quotations available. (*a*) Delivered Sheffield or Glasgow. (*b*) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

British Unemployment.

HAVING no unemployment of their own, and being obliged to make up for a deficiency of labour by importing foreign hands, the French never grasped the seriousness of the unemployment problem in Great Britain until its danger was brought home to them by the influence it was exerting upon questions affecting their foreign policy. Recent events have shown them that there can be no permanent national prosperity which is not based upon an attempt to bring Europe back to something like its old economic condition. The commercial interests of all countries are so closely bound up that a programme of national development which does not take into account the necessities of other nations is bound to fail, as it has already failed in the relations with Italy, Spain, Portugal and even with Belgium. The unemployment in Great Britain is one result of the purely national policy of foreign countries which seek to protect newly created industries, and incidentally to provide funds for impoverished exchequers. The creed of the "balance of trade" was never carried to the extent it is now. Every country endeavours to reduce its expenditure on foreign goods and produce, forgetting that a surplus of imports may contribute to the national prosperity if it is in the form of raw or partly manufactured material to be worked up in the country or if it reduces living costs and permits of a lowering of production costs. The conditions here are now so favourable to a surplus production that something must be done to encourage a foreign demand and settle the many outstanding questions which prevent a revival of confidence, and it is feared that there can be no confidence so long as the problem of British unemployment may provoke social troubles on the Continent. The French Government is therefore desirous of doing what it can to alleviate the unemployment in Great Britain, and has requested manufacturers in the northern departments to state the number of skilled British hands to whom they can offer employment. There is no doubt that firms in the north will be glad to accept the services of skilled British workmen, especially in the textile and engineering industries, and the experiment should be as successful as the placing of a number of British workers with engineering firms in the neighbourhood of Paris several months ago. There is, nevertheless, a risk that a good deal of valuable labour may be in this way definitely lost to Great Britain. The experiment is particularly interesting to French firms for the reason that the dearth of French skilled hands is becoming very serious, and the competition to secure good labour is one of the causes of the steady increase in wages. In one small engineering shop, taken at random, I find that at least 25 per cent. of the hands are foreigners, chiefly Hungarians, Poles, Czecko-Slovakians and Swiss. While the French Government is disposed to help in providing some solution of British unemployment, it is also preparing the way for a reform in the system of commercial treaties with a view to securing permanent advantages on a reciprocal basis. The short-term treaties have been more or less a failure, and in view of the fact that during the first ten months of the year the value of goods sold to Great Britain was estimated at 5000 million francs, and that the adjoining countries were valuable customers, it is proposed to enter into commercial treaties for long periods. It is probable that the next few months will see some interesting developments in the commercial relations between the two countries.

Tanks.

The experiments carried out with the different systems of tanks have left military authorities somewhat dubious as to the effectiveness of this weapon of warfare in its present form. In the manœuvres two types of tanks were employed, with the idea of crushing enemy resistance and preparing the way for an infantry advance. The Citroën-Kergesse endless track vehicle has an advantage in speed and handiness of control, but the armoured turret is far too light to offer any serious protection, and the use of rubber tracks, which can be easily destroyed by obstacles on the road, is regarded as a drawback. The other type of tank has a fairly powerful armament, but it weighs 70 tons, and is merely a development of the vehicles used during the war. It is argued that the tank will be always fighting for supremacy with the gun, and that already the machine must have armour 25 mm. thick and be able to fire a projectile that will perforate 30 mm. at a distance of 300 m. The natural consequence of this struggle between the armour plate and the gun is the construction of increasingly heavy machines, which, if they are fitted with endless tracks, will not have the necessary speed for travelling from one field of operations to the other. This means that they will be dependent upon the railway, which will limit its dimensions. Some authorities therefore suggest that the tank should be able to travel on wheels, even when operating in a hostile country, and that it should be possible to transfer rapidly the road wheels into an endless track when the vehicle has to overcome obstacles. From the French point of view, the problem of the tank is still far from being satisfactorily solved.

Electrical Distribution.

The utilisation of hydraulic power for the production of electrical energy is being carried out in pursuance of a general plan prepared by the Ministry of Public Works. Concessions for hydro-electric installations are only granted when they fall in with this plan, which is intended to prevent a wasteful expenditure of money, and to ensure that the installations are necessary for the general scheme of electrification. This does not, of course, include hydro-electric plants for industrial or local purposes. Now that the organisation of hydro-electric production is nearly completed, the Minister of Public Works has appointed a Committee to organise the distribution, which is to be arranged in such a way that various centres of production will be dependent on each other, so that a period of low water in one may correspond with a period of high water in another. At the same time, the centres of distribution will be linked up as far as possible with heat plants. It is hoped that the organisation will ensure a regular distribution of energy independently of the variations in the sources of supply.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

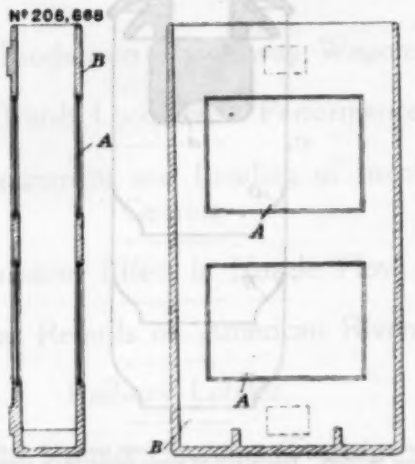
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

BATTERIES AND ACCUMULATORS.

206,668. October 11th, 1922.—IMPROVEMENTS IN ELECTRIC ACCUMULATORS, Joseph Albert Hill, of Ordnance Works, Sheffield, York.

The invention relates to an electric accumulator having a box or casing formed from one or more glass or other transparent

N° 206,668



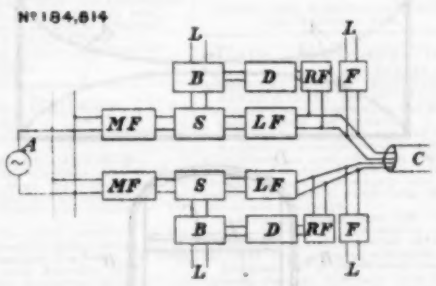
or translucent plates or insets moulded into insulation material, such as that known under the trade name "Mouldensite." In the accompanying drawings A represents the glass insets or panels, and B is the insulating material in which such panels are moulded.—*November 15th*, 1923.

TELEGRAPHS AND TELEPHONES.

184,814 August 22nd, 1921.—IMPROVEMENTS IN HIGH FREQUENCY TELEPHONE SYSTEMS, Gesellschaft für drahtlose Telegraphie M.B.H., 9, Tempelhofer Ufer, Berlin, S.W. 11, Germany.

This invention relates to high-frequency telephone systems, and its object is to provide a system in which high frequency telephony may be employed over conductors which are collected together into cables. The various conductors of a cable are supplied with currents of the same frequency for conversations in the same direction. In order to prevent back action between the different conversations and consequent cross talk between the high frequency generator and a speech modulator a frequency filter called a machine filter is provided, and between the modulator and the cable there is a second frequency filter called the line filter. A is a high frequency generator, which may consist of a machine, a valve or an arc generating oscillations of a frequency F, say, in the neighbourhood of 5000. This is connected to machine filters MF, MF, which have a range of, say,

N° 184,814



500 to 5000. These are connected to speech modulators S S, to which speech currents are introduced over lines L L, through balancing arrangements B B, the result of the modulation at a frequency F^1 may be taken to increase F to $F + F^1$. The line filter LF, which is interposed between the modulator S and the cable C has, therefore, a range between F and $F + F^1$. The exchange at the other end of the cable has a generator producing oscillations of frequency F^2, say, 15,000, and the result of the speech modulation will be to increase F^2 to $F^2 + F^1$. Accordingly the conductors are provided with receiving filters RF having a range between F^2 and $F^2 + F^1$. These are connected to the balancing arrangements through amplifiers D D. The low frequency speech lines L are protected by filters F having an upper limit of, say, 3500. Since the upper limit of a machine filter MF is F these machine filters will prevent reaction of one speech upon another, and will prevent reaction upon the generator since the frequency of the oscillations after modulation is above the upper limit of these filters.—*November 15th*, 1923.

TRANSMISSION OF POWER.

184,815. August 21st. 1922.—IMPROVEMENTS IN COUPLINGS FOR ELECTRIC CABLES COMPRISING HARD AND SOFT WIRES, "Felten and Guilleaume Carlswerk Actien-Gesellschaft," of Köln-Mülheim, Germany.

This invention relates to a coupling for cables of two concentric layers of different metals, the outer layer consisting of aluminium. The wires F of the steel core are clamped by a hollow cone E against the inner surface of a concentrically arranged hollow cone A. The aluminium wires D are pressed by the hollow cone A against the inner surface of the conically bored bush B. Two conical bushes B are connected together by means of a threaded bush C. G is an intermediate piece, which may be omitted. Experience shows that aluminium wires held in cones easily give and are then liable to become fused. Should this occur in the coupling described, that is, should the outer aluminium wires D give, the tension exerted on the steel wires F causes the wires F, together with the cone E to be drawn further into the cone A. This causes the cone A to be drawn further into the conical bush E,

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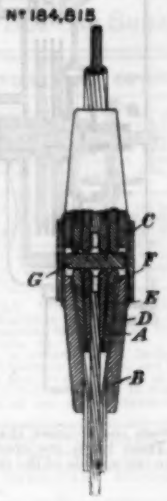

so that, by the tension exerted on the cable, in the event of the wires giving, the entire arrangement is automatically tightened again and the wires always remain pressed firmly against the walls of the cone and of the conical bush B. This, it is claimed, always insures a good electrical contact, even in case the steel wires should have to take over the conduction of the current, as the current will then pass to the other side by way of A, B, C.—*November 15th*, 1923.

TRAMWAYS AND RAILWAYS.

206,755. January 19th, 1923.—CONCRETE SLEEPERS, B. Sani, No. 0672 Viale del Re, Rome, Italy.

This reinforced concrete sleeper is of trapezoidal cross section and has a wider base, as shown at A, beneath the rail seats

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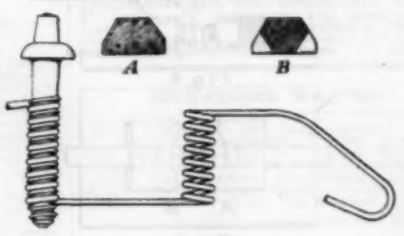

than it has for the remainder of its length—see B. Screw spikes are used for securing the rail and are screwed into spirals of wire—shown in the detail sketch—which are embedded in the concrete. Two sets of spirals may be used, so that varying gauges can be accommodated.—*November 15th*, 1923.

FURNACES.

206,738. December 28th, 1922.—STEP GRATES FOR BOILER FURNACES, *Babcock and Wilcox, Limited, Oriel House, Farringdon-street, London, E.C.* 4.

In this furnace the grate steps are pivoted in bearers at A and rest on stops B. Beneath them there run sets of chains C, on which there are fixed projections D. As these projections are drawn up, beneath the grate, the steps are, one by one, gradually

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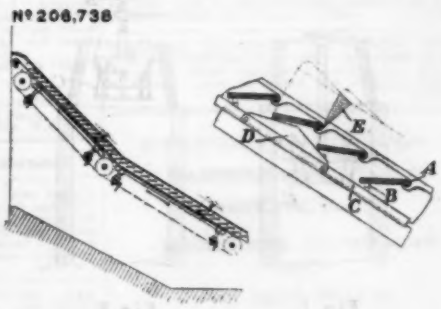

tilted and lowered gently on to their stops again. In the process the fuel, indicated by the cross-hatched area E, is tipped over on to the bar below that on which it has just rested. A scheme for the arrangement of the chains is shown, while another view not reproduced, indicates multiple cam shafts in place of the chains and projections.—*November 15th*, 1923.

SHIPS AND BOATS.

206,772. February 26th, 1923.—SHIPS' TELEGRAPHS, F. W. Wood, Montclair, Essex County, New Jersey.

The inventor suggests that the ordinary ships' telegraph warning signal may not be noticed in the engine-room of a

vessel equipped with Diesel engines, on account of the noise made by the engines. Consequently, in place of the usual gong he employs a set of diaphragm horns A, similar to those used

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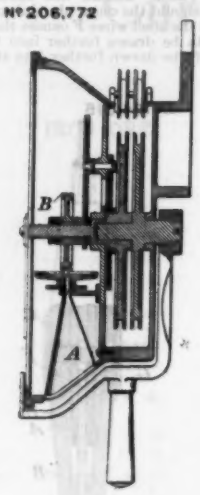

on motor cars, to warn the engineer that the telegraph has been manipulated. These horns are operated by a serrated disc B geared up from the spindle of the telegraph as shown.—*November 15th*, 1923.

MOTOR CARS AND ROAD TRAFFIC.

206,758. January 27th, 1923.—REAR AXLES, A. C. Scott, 14, Brougham-place, Edinburgh.

This specification covers a process for the forging of back axles for motor vehicles from tubing. The blank is shown in Fig. 1, and is pressed out roughly to the shape indicated in

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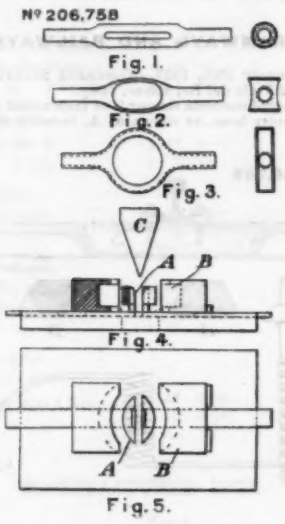

Fig. 2 by simple tools. It is then transferred to the tool illustrated by Figs. 4 and 5, which comprises two sliding internal formers A A and two fixed dies B B. The formers are pressed apart by the wedge C and the finished shape—Fig. 3—thus given to the axle.—*November 15th*, 1923.

METALLURGY.

206,680. October 23rd, 1922.—FEEDER HEADS FOR INGOT MOULDS, W. H. Preston, 66, Mitchell-road, Woodseats; H. Titterton, 24, Francis-street, Attercliffe; and D. T. Turner, 43, Brook-road, Meersbrook—all of Sheffield.

This device is intended for preventing the dropping of rubbish

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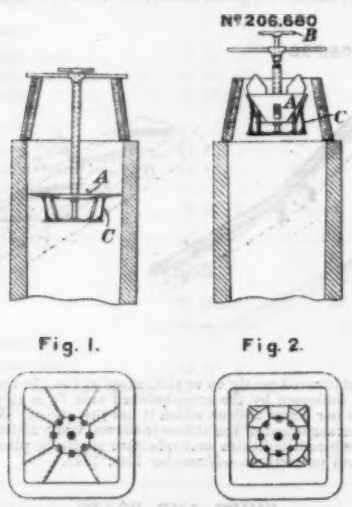


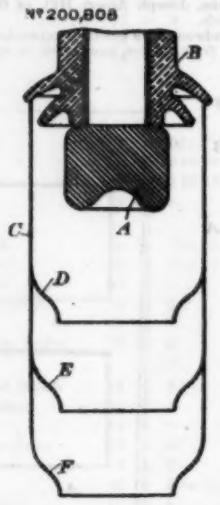
into the ingot mould during the process of fixing the feeder head. It is inserted as shown in Fig. 1, when the plates A A completely fill the opening of the mould. When the head has been fixed the handle B is pulled up and the hinged struts C collapse the plates—as shown in Fig. 2—when the device can be withdrawn through the opening of the feeder head.—*November 15th*, 1923.

MISCELLANEOUS.

200,808. July 3rd, 1923.—IMPROVEMENTS IN ANODE CASINGS FOR MERCURY VAPOUR RECTIFIERS, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

For the purpose of aiding the valve action of the rectifier and preventing the reversal of the current which takes place in back ignitions, it is usual to give a peculiar conformation to the casing that surrounds the anode. Thus, the casing has been constricted to a certain extent at its lower part because experience has shown that this constriction of the outlet aperture for the arc increases the valve action of the rectifier. This simple funnel-shaped conformation of the casing, however, does not prevent the occurrence of back ignitions, so that hitherto this expedient has not been found satisfactory. The object of this

No 200,808



invention is to provide an improved anode casing for mercury vapour rectifiers. This improved anode casing has a plurality of funnel-shaped constrictions situated one behind the other, which must be passed in succession by the arc issuing from the anode on its undivided way to the cathode. This successional arrangement of a plurality of funnel-shaped constrictions increases the valve action very considerably, so that the rectifier is practically closed to the passage of a current of opposite direction. A is the anode, B is the insulator carrying the anode and the casing, and C D E F are the funnel-shaped constrictions of the improved casing. These constrictions do not hinder in any way the passage of the arc from the anode to the cathode, but they prevent the formation of an arc in the case of a reversal of the direction of the current.—*November 8th*, 1923.

206,256. August 9th, 1922.—IMPROVEMENTS IN VENTILATORS, G. D. Peters and Co., Limited, of Windsor Works, Slough, and Aloysius Brackenbury, of 5/162, Westbourne-terrace, Hyde Park, London, W. 2.

This invention has reference particularly to ventilators suitable for application to passenger and other compartments of a railway or other moving vehicle. The ventilator shown comprises an air duct, consisting of two open-ended tapering portions A A, the larger ends of which are flared. The air duct shown has vertical side walls B, and is of the same width throughout its length, the top and bottom walls of the air duct being bent respectively upwardly and downwardly towards the ends of the duct in order to provide a passage increasing gradually in cross section from its centre outwardly. A slot or opening C formed

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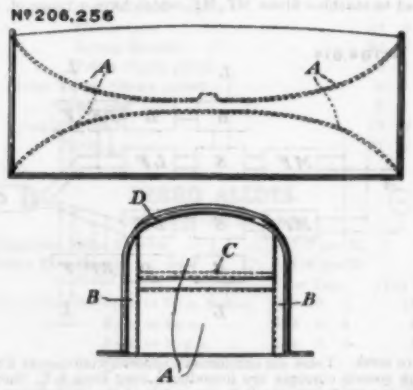
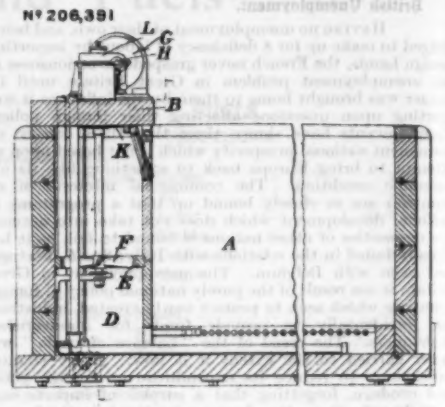


in the top wall of the air duct places the air duct in communication with a surrounding casing D, the bottom of which is open and communicates with the compartment or chamber to be ventilated. The casing is otherwise closed, and its only communication with the duct is by means of opening C. The duct is of less width than the casing, so that vitiated air can reach the upper side of the duct through the spaces between the side walls B of the duct and the side walls of the casing D. At opposite sides of the slot C the lips or edges of the top wall or plate of the duct are bent or curved upwardly to form a sudden enlargement of the air duct, in which an effective vacuum is created as the air which enters an open end of the duct and is compressed flows at increased velocity past such enlargement.—*November 8th*, 1923.

206,391. December 8th, 1922.—IMPROVEMENTS IN GEAR FOR AGITATING AND CIRCULATING LIQUID IN DYE VATS AND THE LIKE, The English Electric Company, Limited, of Queen's House, 28, Kingsway, London, W.C. 2, and Albert Brier, of Phœnix Works, Bradford.

This invention relates to gear for agitating and circulating liquid which is designed primarily for use with dye vats, but is also applicable for use in cases where similar conditions exist. In the drawings the dye vat is denoted by the letter A and the vat top by B. There is a wall partitioning off the propeller chamber D, from the main space of the vat. Chamber D is divided into two parts by horizontal partition E provided with a circular hole in which works propeller F. The gear comprises a reversible electric motor G driving a horizontal shaft H. The propeller is mounted on a vertical shaft and a heat insulating coupling K is inserted in this vertical shaft. A speed-reducing gear L connects the horizontal shaft with the vertical shaft.

No 206,391



The function of the heat-insulating coupling is to prevent the transmission of heat from the hot liquid in the vat A to the speed-reducing gear and to the motor, thus protecting the lubricating arrangements of the gear and of the motor, as well as the insulation of the latter.—*November 8th*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

1924.

WEDNESDAY AND THURSDAY, JANUARY 2ND AND 3RD.

PHYSICAL SOCIETY OF LONDON AND THE OPTICAL SOCIETY.—Imperial College of Science and Technology, South Kensington, S.W. 7. Annual exhibition. 3 p.m. to 6 p.m. and 7 p.m. to 10 p.m.

FRIDAY, JANUARY 4th.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Lecturette, "Economy of Fuel by Removal of Soot from Boiler Tubes," by Mr. L. Manico. 7.30 p.m.

TUESDAY, JANUARY 8TH.

JUNIOR INSTITUTION OF ENGINEERS.—Cannon Street Hotel, E.C. 4. Dance. 7 p.m.

FRIDAY, JANUARY 11TH.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, S.W. 1. Paper, "Concrete Engineering," by Mr. C. O. Mourant. 7.30 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

R. H. LONGBOTHAM AND CO., Limited, advise us that they have removed their chief office from Doncaster to 18, Adam-street, Adelphi, London, W.C. 2, although they will continue to have a branch office at Prudential Buildings, Doncaster.

HENRY LEA AND SON, consulting mechanical, electrical and heating engineers, of 38, Bennetts-hill, Birmingham, inform us that as from December 27th, 1923, their new address will be 1, Newhall-street, Birmingham. Telegraphic address, "Engineer, Birmingham;" telephone number, Central 113.

WE are asked to state that Mr. J. Dorman, has resigned the position of engineer to Marine and Locomotive Superheaters, Limited, and British Ljungstrom Marine Turbine Company, Limited, and that he proposes to commence business as a consulting marine and mechanical engineer at 24, Lower Leeson-street, Dublin, on January 1st, 1924.

THE OXFORD STEAM PLOUGH COMPANY, Limited, of Cowley, Oxford, informs us that, having found that its name, which it has held for fifty-five years, is somewhat misleading to prospective customers, it has decided that on and after January 1st, 1924, the name of the company shall be: John Allen and Sons (Oxford), Limited. This change, we are informed, is purely a nominal one, no alteration having taken place in the ownership, management, or policy of the company.

BREAKING UP OF SCRAP METAL.—In connection with the short article on the breaking up of scrap metal by means of explosives, which we published in our issue of November 16th, Nobel Industries, Limited, have sent us a little booklet dealing with the subject. In it there are some excellent hints on the best methods of using explosives for such purposes, for ship breaking, excavating and deepening rivers, together with brief particulars as to the appropriate charges for various classes of work.

THE SOCIETY OF ENGINEERS.—We have received from the Secretary of the Society of Engineers the following list of Premiums awarded by the Society for papers read before, or published by, it during 1923:—President's Gold Medal to Mr. J. W. Gordon, K.C., for his paper on "Railway Surveying by Photography"; Bessemer Premium (value £5 5s.) to Mr. P. Mauclere for his paper on "The Pneumatic Handling of Petrol and other Inflammable Liquids"; Nursey Premium (value £3 3s.) to Mr. A. Hiley for his paper on "The Impact of Imperfectly Elastic Bodies, with Particular Reference to the Effect of the Hammer Blow in Pile Driving"; Bernays Premium (value £3 3s.) to Mr. A. Ferguson for his paper on "A New Entirely Automatic Machine for the Mass Production of Glass Bottles"; Society Premium (value £3 3s.) to A. S. E. Ackermann for his paper on "The Physical Properties of Clay (fifth paper) and the Dynamics of Pile Driving"; Clarke Premium (value £5 5s.) to Mr. R. C. Hill for his paper on "Work Beneath the Waves," read before the Gloucestershire Engineering Society, associated with the Society of Engineers; and Geen Premium (value £5 5s.) to Mr. H. F. Jones for his paper on "Boilers," read before the Crystal Palace Engineering Society, associated with the Society of Engineers.